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Molds Car Wheels on Jolt Machines

Made Possible by Adaptation of Conveyor Systems for Transferring Molds, Flasks and Sand, Supplemented by I-Beam Trolleys and Gravity Conveyors—Mold Conveyor Operates in Rectangle

IT IS well known that the perfection and adoption of the molding machine has enabled foundries to make noteworthy reductions in the cost of castings. However, in a great many instances, only a small proportion of the possible savings have been made, due to the difficulties in handling the materials, as well as the completed molds. This is true particularly of foundries producing cast-iron car wheels, and mainly for this reason, molding machines have been but little used in this branch of the casting industry.

Handling equipment in conjunction with molding machines for making car wheels recently was installed at the Brown Car Wheel Works, Inc., an old established firm in Buffalo. Inasmuch as many of the methods adopted had never been applied previously, it was decided to remodel the existing plant, and while this necessitated an arrangement of equipment to suit the building, little in the way of efficiency was sacrificed. The plant originally was 70 x 170 feet and had a capacity sufficient for casting 200 car wheels per day. The molding was all done by hand, and the wheels were poured between the hours of 1 and 5 in the afternoon by three pouring gangs. Now the plant is 70 x 80 feet with the same

Information for this article was supplied by Herbert H. Leonard, president, Industrial Planning Corp., Buffalo.

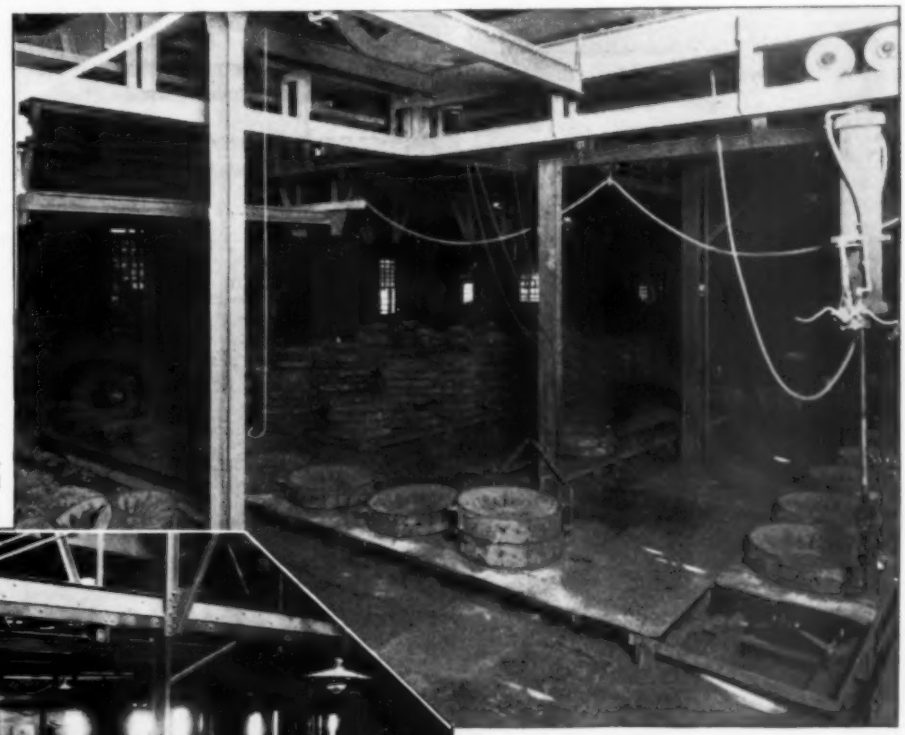


FIG. 2—WITH THE CONVEYOR SYSTEM ONLY ABOUT HALF THE FLOOR AREA IS REQUIRED

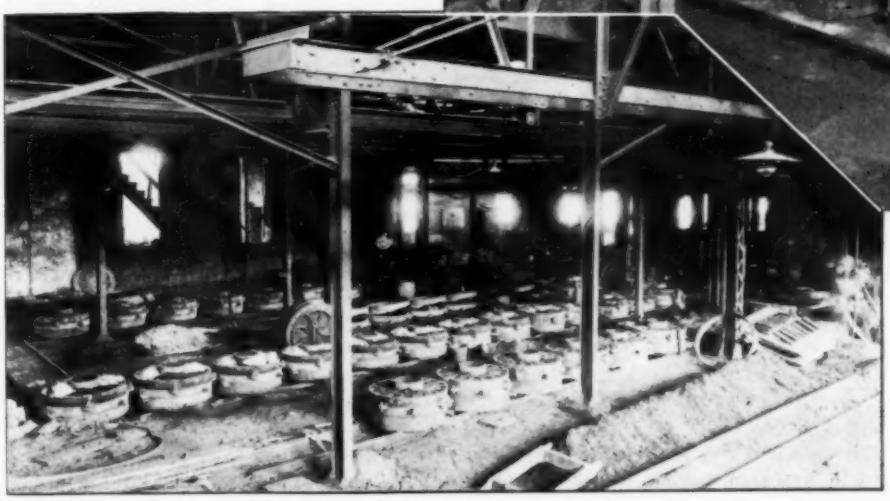


FIG. 1—VIEW ACROSS THE SHOP WHEN WHEELS WERE HAND MOLDED

production as in the larger shop. One gang pours during the entire day.

Due to the size and weight of the castings, and the large amount of sand required, it was felt that to obtain the greatest economy from molding machines, it would be necessary not only to convey the sand to the molding floor by mechanical means but also automatically to convey the molds from the molding machines. Thus, it would become possible to consider continuous pouring of the castings, and the installation was designed with this end in view.

The process of making car wheels is so well known that no attempt will be made to describe it in detail. The molds are made in two-part round cast-iron flasks, the chiller for chilling the tread of the car wheel being bolted to the cope flask. Fig. 1 shows a view of the foundry before the changes were started. It may be noted that the molds, ready for pouring, cover the entire floor as is usual with hand molding.

The proposition was analyzed into the essential elements as follows:

Automatic delivery of sand, properly screened and tempered, to the molding machines.

Mechanical removal of the molds from the molding machines and then delivery to the pouring position.

After an allowance of time for the castings to be slightly cooled, the removal of the sand and castings from the molds; the delivery of the castings to the soaking pits, the sand to the sand storage, and the flasks back to the molding machines.

Mechanical handling of the molds was thus the major feature and was accomplished by a moving platform of unique design composed of cars running on a track layout of rectangular shape, as may be seen from Fig. 3, which is an outline plan view of the installation.

Carry Molds on Cars

This moving platform *P*, Fig. 3, is composed of cars of suitable size for a mold, mounted on wheels and so designed that upon arriving at a corner they automatically start in a direction at right angles to that in which they previously were moving. This is accomplished by the mechanism of the wheels as the platform does not turn. This feature, as well as several others, is patented by the Brown company.

The lines of cars on each side of the rectangle are operated independently by pneumatic equipment. The motion of the platform is intermittent, and can be regulated to suit any condition required. The cars start slowly propelled by the rear car on each line actuated by pneumatic equipment. After attaining maximum speed they gradually are retarded. With this method of movement of the platform the closing of the mold, as well as pouring, is done while the platform is at rest.

It may be noted from Fig. 3 that there are two less cars than would be required to fill the rectangle completely. The description of the operation of the platform will make clear the necessity for this.

The movements of the four sides of the platform are controlled pneumatically from the station *F*, Fig. 3, which is elevated to give the operator an unobstructed view of the foundry. Upon movement of the control lever by the operator the platform on one side of the rectangle is advanced a distance equal to one car length, the open space at the end of this line permitting this. The platform on the opposite side is then advanced an equal distance, thus leaving a vacant space at the end of each of the other two sides which are then successively advanced the same amount. The movement of the entire platform is thus made in increments equal to the length of a car. The control also is designed so that it is impossible to advance the platform on the four sides except in the correct sequence. The actuating system is further provided with an emergency stop which will enable any side to be brought to rest instantly.

The track upon which the car runs

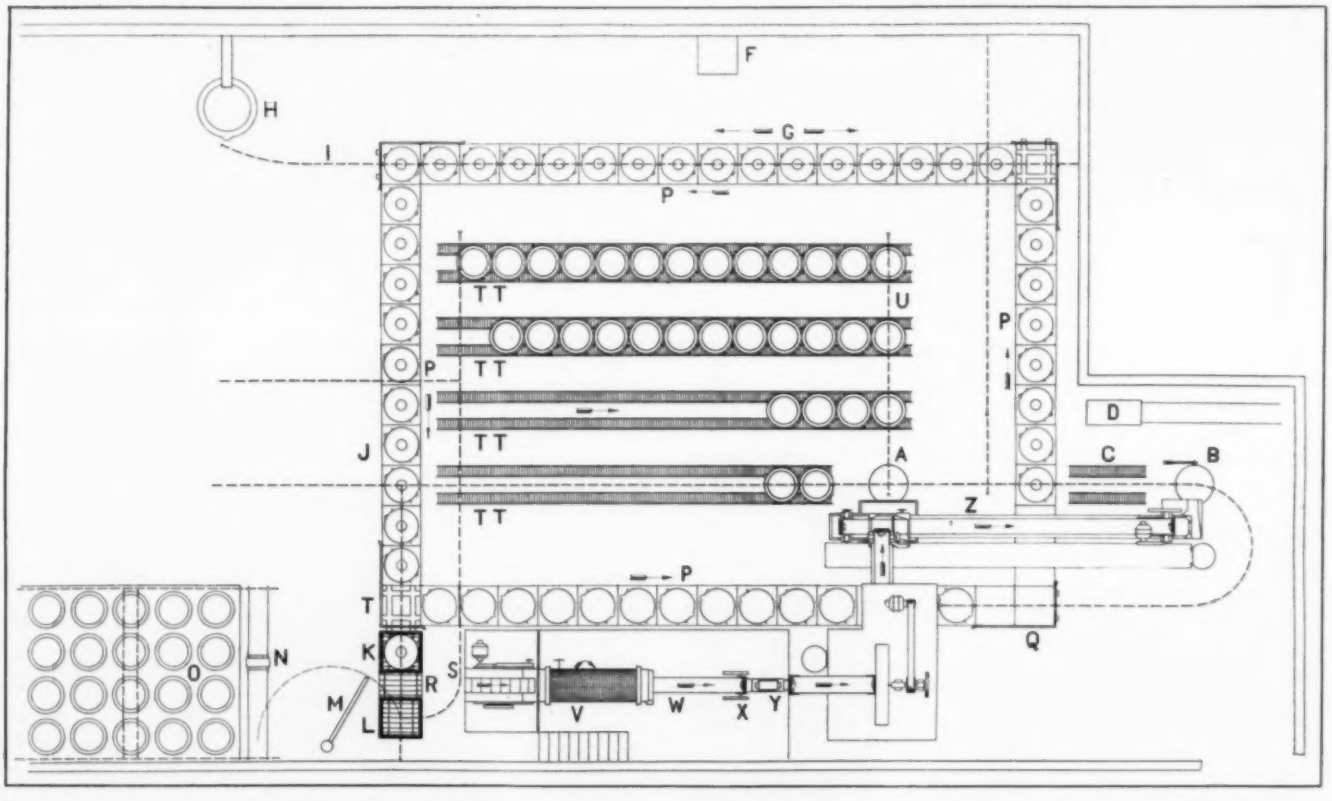


FIG. 3—DRAGS ARE MADE ON THE MACHINE *B* AND COPES ON *A*, BEING BROUGHT TOGETHER ON THE PLATFORM CONVEYOR *P* WHICH CARRIES THE MOLD TO THE SHAKE-OUT MACHINES *K* AND *L*—ON THE WAY THE MOLDS ARE POURED AT *G*—NOTE THE GRAVITY CONVEYORS *TT* FOR STORING COPES WITH CHILLERS

FIG. 4—DRAGS ARE MOLDED ON A JAR-RAM, ROLL-OVER MACHINE AND SET ON A GRAVITY CONVEYOR TO BE FINISHED FIG. 5—THE MOLD IS CLOSED WHILE THE DRAG RESTS ON THE CONVEYOR WHICH IS STATIONARY AT THE TIME

is placed well above the level of the foundry floor, preventing sand and dirt from getting on it. The sides of the cars, which overhang the track, are machined to exact size on all sides, and as they are in close contact, there is no opportunity for sand to fall between the cars onto the track.

All molding is done with cast-iron patterns on two machines furnished by the Herman Pneumatic Machine Co., Pittsburgh. The molding machine *B*, Fig. 3, used for making the drags, is of the jar-ram, rollover type and is located at a distance from the platform *P*, allowing a gravity conveyor to be installed between it and the platform conveyor. Two men operate the machine, throwing sand into the mold and jarring it, then drawing the pattern and rolling it over onto a section of the gravity conveyor which is raised to receive it. The machine and a part of the conveyor may be noted in Fig. 4. No bottom board is used, but the drag flask is barred and set on two boards on which it travels on the grav-

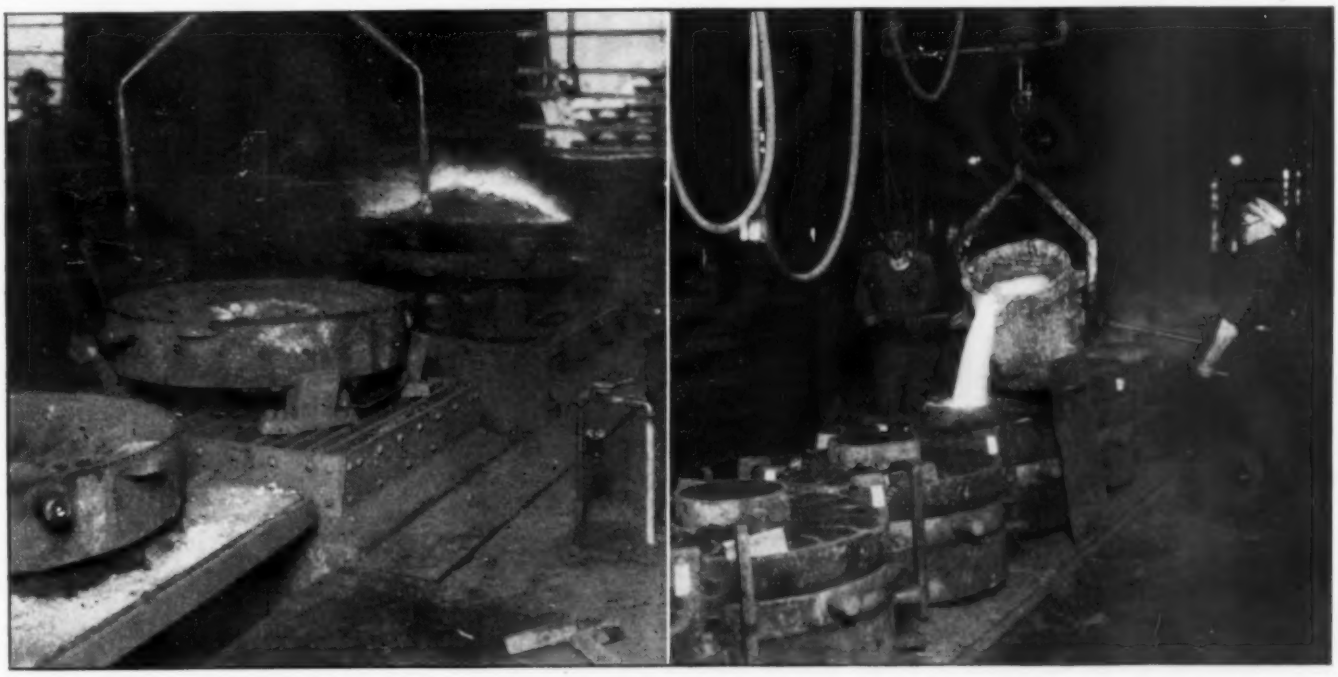


FIG. 6—MOLDS ARE SHAKEN OUT ON JARRING MACHINES AND THE DRAG FLASK IS TAKEN TO THE MAIN CONVEYOR WHILE THE COPE WITH THE CHILLER IS CARRIED TO STORAGE AND THE WHEEL LIFTED TO THE SOAKING PITS FIG. 7—ALL MOLDS ARE POURED AT THE SAME STATION

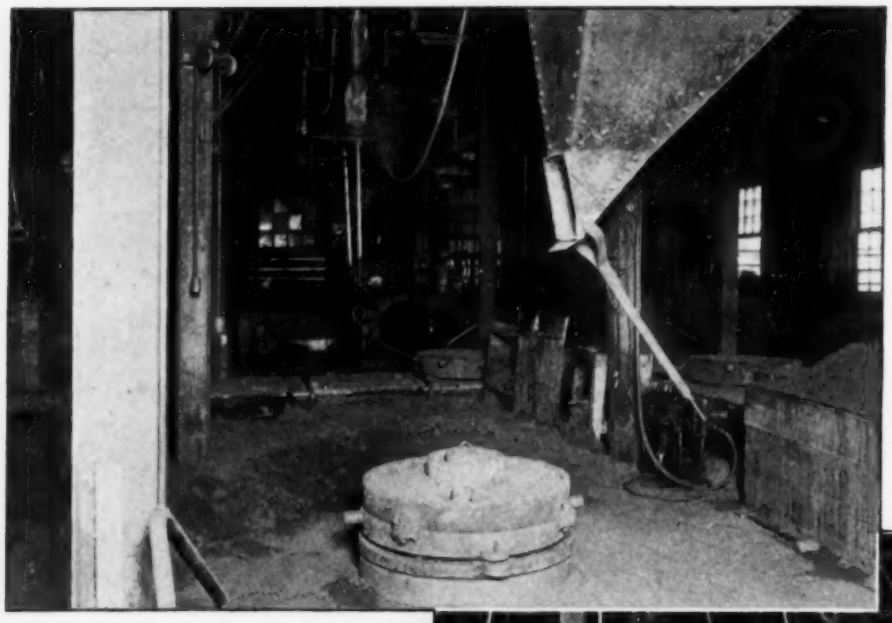


FIG. 8—A TROLLEY WITH AN AIR HOIST CARRIES THE COPE MOLD FROM THE MACHINE AT THE FRONT TO THE MAIN CONVEYOR

ity conveyor. The elimination of the bottom board allows the drag to vent freely.

When the drag is placed on the raised section of the gravity conveyor, it is face up and the section of the conveyor is lowered to allow the mold to slide down the length of the conveyor. At this point the mold is slicked by a workman who also sets the cores. The cores are delivered to the station *D*, Fig. 3, on a truck. While the mold is being slicked and the cores set another mold is in preparation and a flask is being brought for the next mold by a fourth workman. The finished drag is then transferred from the lower end of the gravity conveyor to a car of the moving platform by an air hoist, the distance being only a few feet.

Simultaneously with the molding of the drag, a cope is being made on the molding machine *A*, Fig. 3, also of the jar-ram type. The cope is carried from the machine by an air hoist traveling on an I-beam. Suspended

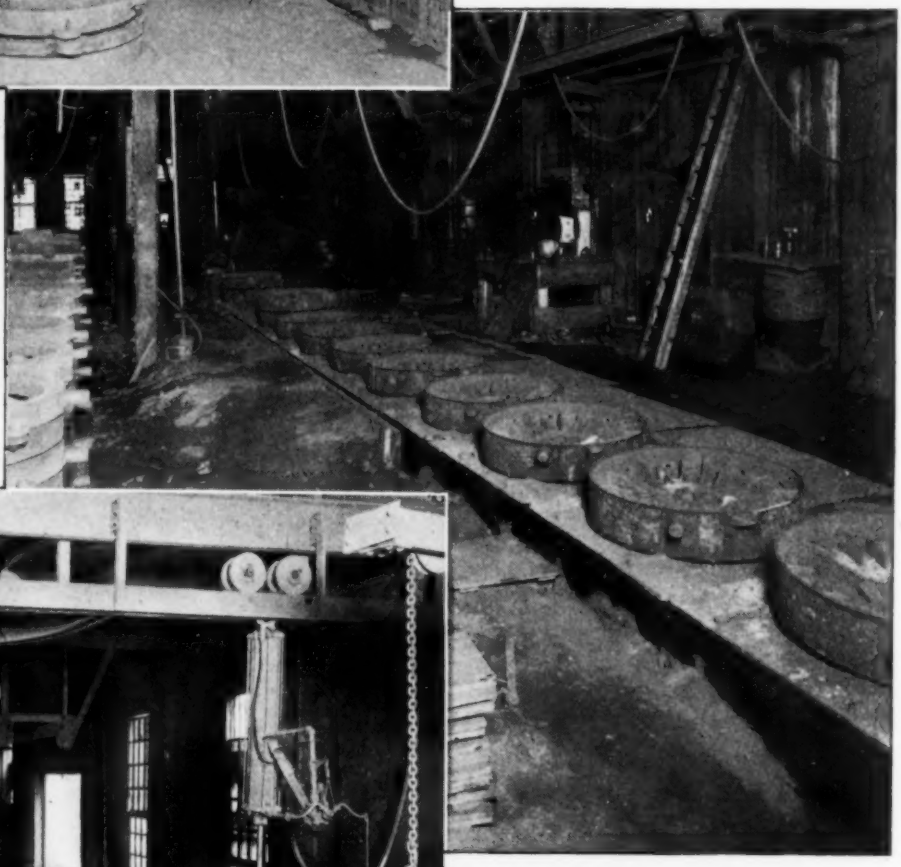


FIG. 10—MOVEMENT OF THE CONVEYOR IS CONTROLLED FROM THE PLATFORM SHOWN AGAINST THE WALL

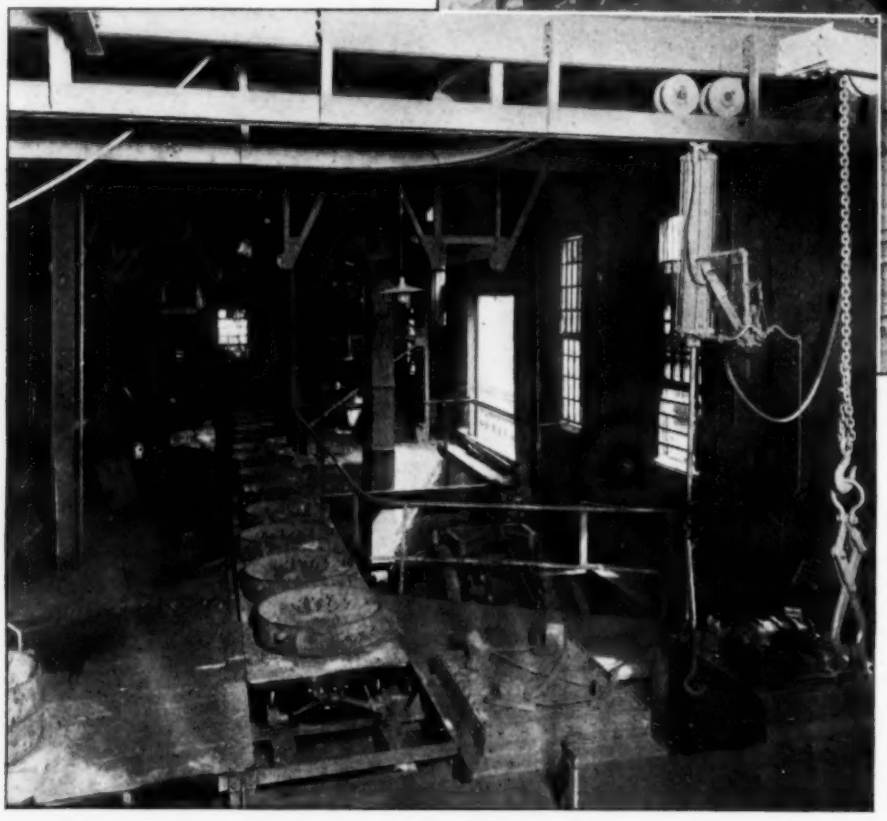


FIG. 9—THE TWO SHAKE-OUT MACHINES SHOWN AT THE RIGHT ARE LOCATED AT ONE CORNER OF THE PLATFORM CONVEYOR—SAND FALLS THROUGH GRATINGS TO A HOPPER BELOW

by the hoist, it is finished, then closed on the drag which has been placed on the car *E*, as already noted. Fig. 5 shows the cope being lowered onto the drag which is resting on the platform.

Fig. 8 which is a view across the two molding machines, with the machine for molding the cope at the front, makes clearer their relative arrangement. It may be noted that a trolley carrying an air hoist passes directly over the center of each machine and across the platform. The hoist carries a bale engaging trunnions on the flask,

making it easy to turn the mold as required. The sand chute for delivering the sand to the flask is shown clearly and will be described later. The trolley installation was manufactured by the Whiting Corp., Harvey, Ill., and the air hoists were supplied by the Curtis Pneumatic Machinery Co., St. Louis.

The movement of the platform carrying the molds to the position *G* which is the portion devoted to pouring may be better understood by referring to Fig. 3. The mixing ladle *H* receives the molten iron from the cupola. From this ladle, the iron is poured into a secondary ladle carried by an air hoist suspended from a trolley moving on the track *I*, which is directly over the center of the platform, and permits pouring along this side.

Fig. 10 shows clearly the relation of the pouring track to the platform. The flasks shown on the platform are empty, as this picture was taken when the foundry was not in operation. The control station on the raised stand for the operation of the moving platform can be seen along the wall.

The time required for the platform to advance from the pouring position *G* to the section marked *J* in Fig. 3 allows the castings to cool. At *J* the flasks are unclamped, preparatory to shaking out. A trolley line *R* equipped with air hoists, passes over the center line of the platform *P* and the shake-out machines *K* and *L*. The complete mold containing the casting is lifted from the platform and deposited on a shake-out machine *K*. The cope holding the casting is then lifted off and deposited on shake-out machine *L*. *K* is then jarred sufficiently to shake the sand out of the drag, the sand falling through the grating shown.

Fig. 6 shows the two halves of the mold on the jolt shake-out machines which were made by the Herman Pneumatic Machine Co. These are ready for shaking out the sand. The drag at the left is resting on four cast-iron seats bolted to the crossbar of the jolting table. When the sand is shaken out the drag flask is lifted back and deposited on a car which is in position *T*, Fig. 3. The sand from the cope falls through the grating and the empty flask is lifted off by an air hoist suspended from a trolley and running on the track *S*. This track passes over the lines of the gravity conveyors *TT*, furnished by the Mathews Gravity Carrier Co., Elwood City Pa., which are pitched toward *U*. The copes with the chillers are piled four high on the gravity conveyors and then let loose to travel toward the lower end. Fig. 2 which is a view taken from the same position as Fig. 1, shows the storage of empty copes on the gravity conveyor. As the copes must be cool before using, it is desirable to provide at least a day's supply ahead.

After the cope is removed from the shake-out machine the casting, resting on a cast-iron form bolted to the table of the machine, is jolted to remove the loose sand. It then is lifted off by a jib crane *M* Fig. 3. All sand clinging to the wheel is knocked off with sledges before the wheel is deposited on the transfer car *N* ready to be put into the soaking pits *O* by a traveling crane. Fig. 9 shows the two shake-out machines and their relation to the moving platform, as well as some of the sand handling equipment located in a pit below the floor level. With this arrangement the distance covered from the shake-out to the soaking pits is only 15 feet.

The sand falls through gratings to a hopper under the floor which deposits it on an inclined pan conveyor passing it to the screen *V*, Fig. 3, which riddles it and removes all foreign material. Fig. 11 shows this rotary screen and a small section of the sand conveyor underneath. The sand falls from the screen onto the belt *W*, Fig. 3, passing over the magnetic pulley *X* which removes any iron which passed the screen. From the belt *W* the sand falls into a hopper at the bottom of the bucket elevator *Y* which carries it to the top of the building. It then passes through the areator, is tempered and dumped into a storage bin to allow for seasoning. From this bin it is carried by belt conveyors to a second belt conveyor *Z* which distributes it to temporary storage bins over each molding machine, one of which is clearly indicated in Fig. 8. The sand handling equipment was installed by C. O. Bartlett & Snow Co., Cleveland.

The empty cope flasks are carried from the lower end of the gravity line *U*, Fig. 3, to the molding machine *A* by a trolley, equipped with an air hoist and moving on a track as indicated by the dotted lines. The drag flask after being placed upon the car at *T*, Fig. 3, is carried along with the movement of the platform until it reaches the point *Q* when it is taken to the molding machine *B* by an air hoist suspended from a trolley and operating on a track as indicated by the dotted line.

The Industrial Planning Corp., Buffalo, designed the installations which was put in under the direction of E. B. Norris, general manager of the plant, to whom its success largely is due.

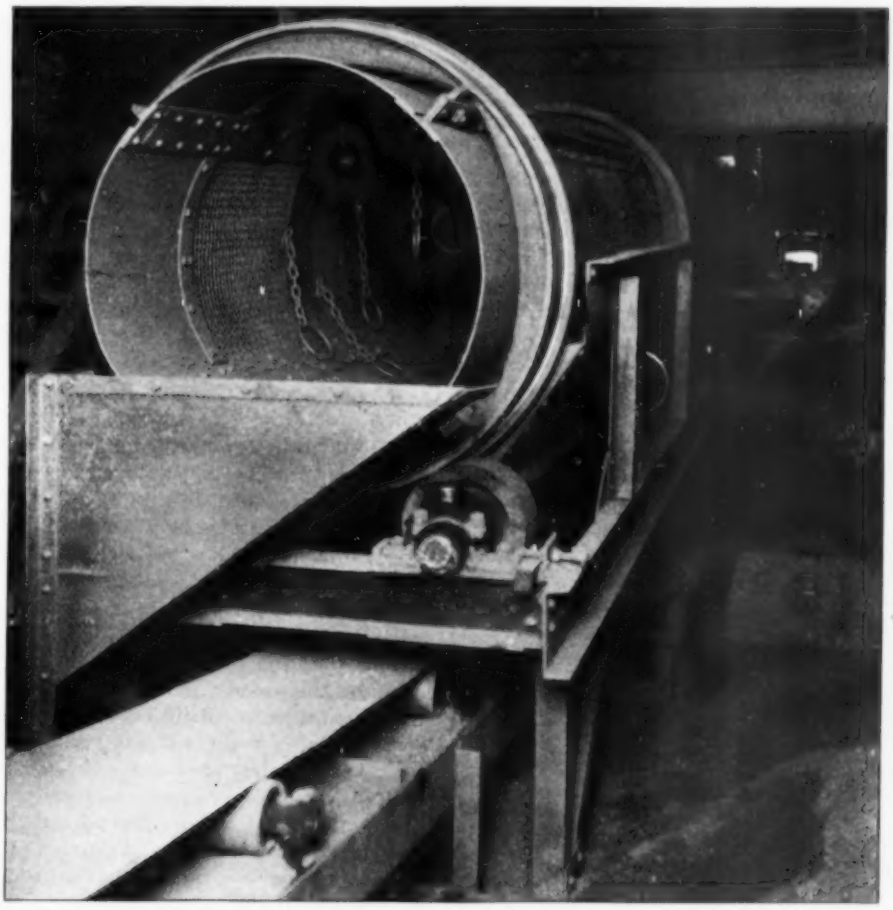


FIG. 11—USED MOLDING SAND IS SCREENED BEFORE IT IS CARRIED TO THE HOPPERS ABOVE THE MOLDING MACHINES

Superheats in the Electric Furnace

Advantages Gained Through Heating Gray Iron for Casting to a Temperature Above That Commercially Possible in Cupola Metal—Basic Process Which Lowers Sulphur Recommended

BY GEORGE K. ELLIOTT

THE electric furnace in the United States has been applied seriously in the gray-iron foundry for nearly five years, and today we find it limited to a comparatively few scattered foundries, probably driven to the innovation by the stress of modern demands for better iron castings. Although interest in the subject is alive and spreading, the great mass of foundrymen still are not well informed about it and look upon the occasional adoption of the electric furnace for such common material as cast iron as either foolish extravagance characteristic of the times, or a display of metallurgical affectation. Decidedly this is not the writer's view, for he believes not only that the electric furnace when coupled with the cupola will gain a widespread use in iron foundries but also that as it attains this it will prove a bulwark against the alarming tendency of malleable cast iron and steel castings to affect a permanent invasion of a field that by rights belongs to gray iron. Such invasion actually began during the war when all branches of engineering pushed on toward super qualities in metals.

The first published accounts in the United States of a working process for gray cast iron involving the electric furnace were two papers read by the author in 1919.* The first use of the electric furnace upon a large manufacturing scale for gray-iron castings was probably in a metallurgical plant specializing in valves, at Cincinnati, Ohio. There, at first it was used for melting and refining cold charges of pig iron and scrap, but soon the process underwent a metamorphosis, becoming a duplexing one that involved the use of the electric furnace and the cupola in tandem operation, the melting being done in the cupola and the remaining operations in the electric furnace. At this plant both the cold-charge melting and the duplexing processes were employed for making gray-iron castings for valves that were to handle power steam of great pressure and high temperature. Some years ago steam engineering reached the point where the staple grades of iron valve castings were unreliable for the service expected. The resultant research discovered that the basic-hearth arc electric furnace of the common types in vogue for steel, could produce gray iron of a better quality than any that previously had been commercially attainable. That was over four years ago and electric furnace processes in that pioneer foundry have been in constant use ever since, and also have spread to other foundries in various widely scattered parts of the country. The duplexing process is employed on the largest scale probably in a pipe foundry that passes over 200 tons of gray iron through the electric furnace every 24 hours.

Used With Discrimination

The purpose of the writer in presenting this paper is to record for the Institution of British Foundrymen some of the main reasons why the basic-hearth electric furnace has vindicated its use for cast iron wherever attempted with discrimination, and why it is likely to do so in all foundries where practice has shaken off the shackles of the crasser forms of competition, pressing on to that enviable position where extreme quality is the first and only desideratum.

Because the cupola is almost the only furnace for melting iron for castings, a few reverberatory furnaces being exceptions, the electric furnace will have to bear strict scrutiny in comparison with the cupola and show noteworthy advantages over it if it is to gain an entree into the iron foundry. The present discussion will compare the two furnaces in their chief aspects, developing the proposition that along certain lines the electric furnace is an admirable adjunct to the cupola whose field of usefulness it materially widens.

No attempt will be made here to describe any of the many current types of furnaces but rather to treat the subject from the standpoint of process and product. The arc-type furnace is presupposed. Furthermore the discussion will be limited to the basic process in contradistinction to the acid, although the usefulness of the latter, mainly for superheating, is recognized. The basic process is so much more flexible, its chemical possibilities so much greater, and in general its potentiality in many practical directions so superior, that it is by far more interesting and valuable than the acid process.

Preheating, melting, refining and superheating are, generally speaking, the four major periods of a complete furnace operation, and they shall serve as the outline to this discussion.

Preheating and melting are accomplished in the cupola so admirably that for simple performance of these duties the cupola is without peer. Its thermal efficiency of probably 40 per cent looms up impressively in comparison with the probable 12 per cent of the reverberatory or air furnace, and the 25 per cent of the reverberatory furnace of the regenerative type. The efficiency of the electric furnace is placed at 60 to 85 per cent. The comparatively high efficiency of the cupola, however, is combined with a simplicity and cheapness of operation that makes it still what probably it always will be—the best and overwhelmingly the most popular furnace for melting cast iron. Occasionally the electric furnace is used for melting cast iron but the practice is rare and limited to small tonnages of small or intricate castings, automobile piston rings being a typical example. It is almost impossible for the electric furnace to compete with the cupola for simple melting.

It seems established therefore that for all except rare instances the cupola is the best and most economical furnace for melting, and for such its retention should be sought assiduously. One ton of coke properly charged in the cupola will melt as much gray iron as not less than 4000 kilowatt-hours of electricity in the electric furnace. The cupola cannot well be spared from the iron foundry, and in preserving it we help create

This paper, prepared by George K. Elliot, chief metallurgical engineer, the Lunkenheimer Co., Cincinnati, is the first of a series of papers to be exchanged annually between the American Foundrymen's association and the Institution of British Foundrymen. The author acknowledges the assistance of his associate, S. J. Felton. The paper was presented in Blackpool, England, Sept. 14, 1921.

*Improving the Quality of Gray Iron by the Electric Furnace, transactions of the American Electrochemical society, 35, 175-181; The Electric Furnace as an Adjunct to the Cupola, transactions of the American Foundrymen's association, 28, 352-361.

the duplexing process wherein it plays a role so important that we can declare that the cupola makes the electric furnace economically possible for cast iron under certain circumstances.

There are probably many foundrymen, experts at handling the cupola, who will dispute any claim that the cupola is a faulty superheater. That the cupola can superheat must be granted, but usually it is to so limited a degree that superheating is not one of its outstanding features. There is good authority for assuming that the temperature at the hottest part of the melting zone is about 4000 degrees Fahr. but the iron, once fluid, has but a few seconds in which to acquire additional heat before being hurried down through the bed-charge of coke away from the hot zone. Terrestrial gravitation is the restraining power to the effective operation of the cupola as a superheating furnace.

Hot Iron From Cupola

Nevertheless we must agree that frequently and consistently really hot iron is obtained in the cupola through a combination of correct charging and operation, good coke, sufficient, but not excessive air blast, and suitable pig iron and scrap. There is reason to believe that gray irons with high melting point— those containing little combined carbon—are capable of reaching higher temperatures in the cupola than dead-white irons with a high content of combined carbon. Both probably solidify at about 2100 degrees Fahr. but melt at widely separated temperatures, i. e., at about 2250 degrees or higher for gray irons and 2100 degrees or less for white irons with nearly all their carbon combined.

Gray iron with only traces of combined carbon will hardly melt at lower temperatures than 2250 degrees Fahr. It might melt at well over 2500 degrees Fahr. were it not for the fact that during the preheating period it dissolves considerable carbon thereby automatically decreasing its melting point. Usually it is between 2250 and 2300 degrees that the gradually decending melting point meets the ascending temperature causing complete fusion of the iron. Evidence is available to indicate that speeding up the heating may cause the temperature to meet the falling melting point further up the scale causing fusion at a higher temperature.

Since its solidifying temperature is about 150 degrees lower than its fusing temperature a gray iron may be said to start on its molten career with that amount of inherited, quasi superheat. This is a distinct advantage over a dead-white iron which at the time of fusion has practically none of this seeming superheat. If therefore, we assume that a gray iron after melting at 2250 degrees Fahr. has a seeming superheat of 150 degrees above the freezing point, and if we compare this with temperatures at which such iron is finally tapped from the cupola, we can estimate with fair accuracy the real and the seeming superheating capability of the cupola.

Used Optical Pyrometer

It happens that the writer has a number of temperature records for molten iron from many sources. These all were made with an improved optical pyrometer of the disappearing-filament type. The apparent temperatures were determined by sighting the instrument upon the stream from cupola or ladle and changing to true temperatures by applying the proper emissivity correction.

A study of these records discloses that in various foundries the temperature of gray iron flowing from the tap-hole of the cupola may range from 2400 to 2670 degrees Fahr. Cupola practice therefore can be divided into three classes according to the prevailing temperature of the iron produced, the classes being as follows:

Excellent cupola practice producing iron at 2600 degrees Fahr. and over.

Ordinary cupola practice producing iron at 2525 to 2600 degrees.

Poor cupola practice producing iron at temperatures below 2525 degrees.

Accepting 2250 and 2100 degrees respectively as the approximate melting and freezing temperatures of gray iron, it may be declared from these records that cupolas are superheating gray iron about 150 to 420 degrees above the melting point, or 300 to 570 degrees above the solidifying point, with 425 to 500 degrees above solidification representing the common run of foundries.

An inquiry into the losses of temperature previous to casting produces interesting results. Referring again to our records we find that the losses given in the following paragraph are fair averages although it must be clearly understood that the loss of temperature for any of the outlined conditions varies widely under the influence of such variables as volume of the molten stream, size of ladle, temperature of ladle, lapse of time, etc.

Iron flowing down a four-foot cupola spout loses about 25 degrees Fahr. There is an average difference of 70 degrees between the stream of iron flowing into a 5000-pound reservoir ladle located at the cupola, and the stream flowing from it. If the iron be poured from ladle to ladle, generally to successively smaller ones, the temperature loss for each transfer is from 70 to 100 degrees. The first mold from a 1000-pound ladle filled directly at the cupola, is poured at an average of 100 degrees below the temperature of the iron emerging from the cupola, while the last mold (referring to small or medium-size castings) is poured after a loss of 200 degrees. If there was an intermediate transfer from ladle to ladle, the maximum loss represented in the pouring of the last mold may be as much as 300 degrees.

Temperature Lost

Analyzing the whole mass of our data, only a very small bit of which we have given here, we find that molten gray iron may drop from 100 to 300 degrees Fahr. in the time between leaving the cupola and entering the mold. Subtracting these losses from the minimum and maximum temperatures given in a foregoing paragraph, it is found that the final temperature at the mold may range from 2100 degrees, virtually the freezing point, to 2570 degrees, depending upon the initial temperature and the method of handling the molten metal. The available surplus above freezing therefore may range from nil to 470 degrees.

Excepting the maxima, the surpluses are not impressive in the light of the journey that lies ahead in the mold itself. This journey, perhaps cold, damp, tortuous and long, will absorb the most if not all the remaining superheat. If the iron be of the low-total-carbon, low-phosphorus, low-silicon variety, there is reason to fear for the outcome. Will there be heat and fluidity enough left after filling the mold, to hold the risers alive and active during the critical period of solidification?

The duties of molten iron do not end with taking the form of the mold, because there still remains the important work of feeding the new-born casting while solidifying, cooling and contracting. For this, fluidity is the needed property. The most powerful factor for fluidity is superheat. However many other elements have a bearing upon it among which are the contents of phosphorus, silicon and carbon, the freedom from dissolved iron oxide and entrained slag, and probably factors concerning which as yet our knowledge is very imperfect. Unfortunately the cupola is not always capable of imparting the needed superheat when facing too many adverse

influences in the iron itself and unfavorable conditions in the patterns. At such times the cupola requires exactly the auxiliary that is supplied in the electric furnace. Superheating in the electric furnace can be made so powerful that ample fluidity becomes inevitable.

Strong Irons Lack Fluidity

Strong irons are generally notoriously lacking in fluidity and must either be limited to castings of heavy sections or be heated to a high temperature before being cast into thin sections. The irons of greatest strength contain only a small amount of phosphorus which element is one of the most powerful aids to fluidity. In gray iron, phosphorus seriously diminishes strength, especially shock-resisting strength, by forming a low-melting, brittle eutectic of iron phosphide and iron, sometimes called steadite, that endows the whole casting with some of its brittleness. The role played by phosphorus in cast iron is important, but in the cupola product it has at times the embarrassing effect of rendering fluidity and strength more or less incompatible. None can gainsay that the cupola owes much to phosphorus. Were phosphorus not present in the great run of foundry irons, the cupola would be far from the effective and popular furnace that it is. If strong irons are low in phosphorus their natural fluidity is low and has to be augmented by raising the casting temperature which places upon the cupola a burden it can handle only imperfectly. The electric furnace on the other hand, can superheat even the lowest phosphorus iron sufficiently to make its fluidity equal to the task of running out perfectly the smallest and thinnest section castings. It throws the whole field of castings open to the so-called nonfluid irons and should be able to popularize certain exclusive grades of iron.

Not infrequently poor coke is the chief factor in the cupola's failure to superheat. Especially during the war and time of labor shortage and unrest, was good foundry coke difficult to attain, and consequently the quality of many iron castings suffered greatly. On the other hand the foundries using the electric furnace in series with their cupola were to a great extent immune from the poor-coke pest. It can be declared that any coke capable of melting pig iron or scrap in the cupola sufficiently for it to be transferred to an electric furnace, can be used with impunity in the duplexing process, because its shortcomings are set right in the electric furnace. However it must not be forgotten that good coke is always desirable for the duplexing process because coke is cheaper than electricity, every extra degree of heat gained in the cupola being money saved in the electric furnace. The electric furnace must not be permitted to set a premium upon bad cupola practice. It overcomes the cupola's deficiencies only at a cost, and after all the best idea of the duplexing process is a perfectly operating cupola delivering its best product for the briefest possible treatment in the electric furnace.

We have seen that the practical temperature limit for gray iron in the cupola is not far above 2650 degrees Fahr. while the general average is much lower. However, once the iron is transferred to an electric furnace progressively higher temperatures become merely a matter of time and electricity, and the foundryman is left to decide if the expenditure is justified by results. With molten iron delivered to the electric furnace at 2450 degrees, the current necessary to superheat to 2750 degrees with incidental refining approximates 200 kilowatt-hours per ton of metal, varying with the size of furnace.

Temperature Limit for Cupola Iron

For most purposes the limit for superheating gray iron in the electric furnace may be set at 2750 degrees, although when needed higher temperatures are readily attained. Nothing is gained by excessive superheating unless it be when a more thorough cleansing of the metal is needed. A temperature of 2750 degrees in the iron delivered by the electric furnace represents a working margin of about 650 degrees above solidification, and, depending upon the method of handling, gives a surplus ranging from 350 to 550 degrees at the mold. If the iron be poured thus the molds may require more refractory sand, and certainly there will be need of better built molds than often are made if an undue number of runouts is not courted. For nonfluid irons and small castings or castings with thin sections this working margin is of inestimable value.

The subject of hot iron can hardly be dismissed without reference to liquid contraction which name was given by Longmuir to the local contraction that occurs in the heavier parts of a casting immediately subsequent to the solidification of the outer surface. The relation of this phenomenon to casting temperature is most intimate, and several investigators, among whom is Hailstone*, have demonstrated that gray iron cast at temperatures in the vicinity of 2600 degrees Fahr. has every chance of being solid, of close grain and maximum strength; cast at medium temperatures, about 2450 degrees, the grain is more open and the strength less; while cast at about 2375 degrees and lower, blow holes appear and liquid contraction cavities are common. If this work be accepted it places the avoidance of liquid contraction within the province of electric-furnace iron since casting at 2600 degrees will often mean a metal temperature at the furnace of 2700 degrees or over.

The peculiarly interesting feature of the basic-hearth electric furnace is its refining power. This operation is almost unheard of in the average iron foundry where at times a simple process of mixing, and consequent dilution of impurities, may be said to take its place. In some high foundry circles the idea of refining is not so much overlooked as religiously avoided. When first proposed, the idea of refining in the electric furnace was tersely rejected by several eminent foundrymen with the comment that one is not looking for refining operations in the iron foundry because refining means oxidation. Their complete conversion was immediate however, when it was made clear that refining in the electric furnace means deoxidation and not oxidation.

At all events the cupola is not a refining furnace whereas the electric furnace with basic lining emphatically is. This furnace with its unlimited capability for the production of heat, its reducing atmosphere, its reducing and intensely reactive slag, and its ready adaptability, is the refining furnace *par excellence*. For refining, it is the opposite of the cupola and the most potent of all furnaces.

Refine by Deoxidation

The important characteristics of refining in the basic-hearth electric furnace are:

It is strongly reducing.

It is degasifying to an appreciable extent.

It is cleansing of entrained slags and oxides.

It is intensely desulphurizing.

Some metallurgists insist that oxygen can be a strongly beneficial element in cast iron, but the writer is not among those who subscribe to the extreme theories of this group. It is probable that oxygen strengthens iron by assisting the retention of carbon in the combined form, but we fear this is at too great cost and that the gain is problematic. Oxidized iron is the natural product of a badly performing cupola and is readily recognized by its treacherous lack of fluidity in spite of apparently high temperature.

*In Carnegie Scholarship Memoirs published by the Iron and Steel institute, London, in 1913 and 1916.

Oxygen seems to raise the solidifying point of iron, making it sluggish and producing castings of unreliable mechanical properties. While such iron itself may be strong, its castings are liable to be openly or internally defective through flaws born of nonfluid metal.

Lack Method for Oxygen Determination

The importance of the question of oxygen in cast iron cannot be overestimated but at present metallurgists and foundrymen are sadly handicapped in their investigations by the lack of ready and reliable means of determining the full amount of oxygen. No analytical way is open by which one can study completely the oxidation of iron or uncover the mysteries shrouding the mechanism of the methods that are used for its deoxidation. There is reason to believe that oxygen can be present in iron in three conditions, namely, (a) mechanically enclosed gases such as CO_2 and CO, (b) gases in solid solution, and (c) oxides of iron, manganese, silicon, etc. The only means for determining oxygen in iron that seems to be in practical operation is the admittedly imperfect Ledebur method which reaches only the lower oxides of iron, the CO_2 and a part of the CO, missing completely the oxides of manganese, silicon and titanium. *Analyses for Ledebur oxygen in gray iron from both stages of the duplexing process, indicate that such oxygen is reduced by the electric furnace stage of the process to from one-sixth to one-third of what it was upon leaving the cupola. Visibly this change manifests itself by increased fluidity, an iron low in iron oxide being more fluid than one high in it with temperatures the same. Therefore the basic electric furnace is seen to have a two-fold influence for increased fluidity, namely, by raising the temperature and by decreasing the oxide.

Of the effect of the electric furnace upon the other gaseous constituents of cast iron nothing is known except upon nitrogen, concerning which the writer has some scant analytical data. Like oxygen this element probably exists in several forms in cast iron. The only form that seems to be within reach of the analytical chemists is combined nitrogen, probably nitride, which responds to analysis by the Allen method. The nitrogen as determined by this method in a number of samples of gray iron melted in the usual way in the cupola, ran from 0.008 to 0.012 per cent, whereas after refining the same irons for about thirty minutes in the basic electric furnace, it was found to be from 0.004 to 0.006 per cent.

There is no doubt that from the viewpoint of economy the most interesting feature of refining in the basic electric furnace is desulphurization. With the bath of sulphur-bearing iron at a high temperature resting upon a bottom of magnesite or dolomite, under a chemically active blanket of calcareous slag, the transfer of sulphur from iron to slag is facile, rapid, and certain. Given the proper conditions in furnace and slag, none of which is difficult to attain, the diminution of sulphur is merely a question of a short time. The following is illustrative of the progress of desulphurization in an iron fairly rich in sulphur:

Sulphur	Time in Electric Furnace
0.156%	As received from cupola
0.133	10 minutes
0.112	20 minutes
0.079	30 minutes
0.036	40 minutes
0.031	50 minutes
0.014	64 minutes

In this case but one slag was used. The heat was continued further than commercially necessary and for practical purposes could have ended after thirty minutes.

The chemical reaction by which sulphur is removed in the basic-hearth electric furnace is as follows:

$$FeS+CaO+C=Fe+CaS+CO, \text{ or}$$
$$Mns+CaO+C=Mn+CaS+CO.$$

That the full reaction is more complex than here indicated is probable although its essential outline is as given. Its significant feature is that sulphur is taken from the iron as insoluble calcium sulphide which however is soluble in the slag. The key to the reaction is the fact that desulphurization is impossible except with deoxidation, the two going hand in hand. The deoxidizing condition is readily obtained by enriching the slag in carbon through the addition of coke dust. Combining with lime the carbon forms calcium carbide which is the necessary agent for the required degree of deoxidation in the metal. Calcium carbide is made possible by the high temperature of the electric furnace. Were the conditions oxidizing, the calcium sulphide would be oxidized to sulphate which would react with the iron to form iron sulphide once more and as such the sulphur would re-enter the bath. Here is a refining reaction that is thoroughly deoxidizing and therefore incapable of harm to the metal.

This ready method of ridding cast iron of the most of its sulphur is of vast and growing importance in current times. The accumulation of sulphur in the world's scrap heap is becoming a problem. Every remelting increases its sulphur, and metallurgists foresee a time when the heaped up sulphur will be a veritable menace. Much poor, high-sulphur coke was used in foundries during the war, and eventually all this sulphur will find its way back to the foundry contained in scrap. Those who use a large proportion of pig iron in their mixtures say there is no sulphur problem for them, but transportation charges universally are becoming so high that some of these for financial reasons may be forced sooner or later either to move nearer to the source of their iron supply, or to make use of the scrap near at hand, which last condition means that they then must face the sulphur problem. Also they may come to the use of more scrap on the ground that it is an economic duty for every foundry to use a just share of the world's huge scrap pile. At all events in the world of cast iron the secretion of sulphur is a menace that looms up in the near future.

The question arises as to how far desulphurization should be carried. The greatest reduction of sulphur in gray iron made by the writer was from 0.171 in the cupola melt to 0.013 per cent in the same iron refined in an electric furnace, with a single slag in eighty minutes. The lowest sulphur attained was 0.009 per cent in some steam-valve castings that probably are the lowest-sulphur gray-iron castings ever made. This extremely low sulphur is reached only by the expenditure of much time and electricity, and, moreover is not recommended to the average foundry at present nor until our knowledge of the benefit of extremely low-sulphur iron has expanded beyond its present confines. An iron casting with 0.030 per cent sulphur contains about 0.081 per cent by weight of structurally free sulphide. If the sulphur be doubled the amount of sulphide still is inconsequential and we doubt if the difference between these two sulphur contents can be measured in the mechanical properties of the castings. However increase the sulphur to 0.10 per cent or over and the resulting 0.27 per cent or more sulphide becomes a sinister factor to be reckoned with.

Limits for Sulphur

Our opinion is that if the sulphur is below 0.07 per cent it cannot be considered dangerous in any ordinary gray-iron casting; above that segregation is liable to occur with harmful results. Sulphurs of 0.05 per cent and under are needed for only unusual conditions and any advantage claimed for them is largely speculative. In the average foundry practical desul-

*J. R. Cain and E. Pettijohn: A Critical Study of the Ledebur Method for Determining Oxygen in Steel. U. S. Bureau of Standards, Technical Paper 118 (1919).

phurization will consist in reducing sulphurs that originally are well over 0.100 per cent to about 0.070 per cent. Such reduction simply means the making safe and useful, irons that are otherwise openly dangerous on account of their hoard of sulphur.

An indirect benefit from reduced sulphur is a saving of manganese. This element has two purposes in iron—to deoxidize, and to minimize the evil effects of sulphur. One part by weight of sulphur is taken in charge by about 1.7 parts of manganese to form 2.7 parts of manganese sulphide, the advantage of the reaction being that it takes place to the exclusion of iron sulphide. The excess of manganese from this reaction helps form the double carbide of iron and manganese. It is well known that manganese carbide is harder than iron carbide, and the hardness of iron castings, especially small ones, is thereby considerably influenced. Therefore a reduction in sulphur may result in an increase in manganese carbide with a parallel increase of hardness.

To consider this situation more mathematically let us assume a gray iron with 0.80 per cent manganese and 0.13 per cent sulphur. This amount of sulphur requires 0.22 per cent manganese, forming 0.35 per cent manganese sulphide, while the remaining 0.58 per cent manganese unites with carbon to form manganese carbide. If the sulphur in this iron be reduced to 0.05 per cent there is needed only 0.085 per cent manganese to account for it and the amount left free to form carbide is increased to 0.715 per cent. This reduction of sulphur therefore directly causes an increase of nearly one-fourth in the amount manganese carbide in the iron. Quite probably this change would not be noticed in the hardness of fairly large castings but there is ample experience indicating that in small castings it is liable to become embarrassingly noticeable.

In the case of sulphur reduction assumed in the foregoing paragraph the amount of manganese carbide can be kept at its original figure by making the manganese correspondingly lower to agree with the reduced sulphur. That is, a manganese content of 0.665 per cent will with 0.050 per cent sulphur give the same amount of manganese carbide as 0.80 per cent does with 0.130 per cent sulphur. In practice this condition is taken care of by using lower manganese irons to begin with whenever electric furnace refining is to follow the cupola operation. This lowering of manganese is accompanied often by definite economic advantages in the purchase of raw materials.

The fact is, the electric furnace conserves manganese in several ways, and lower manganese specifications become compatible with good castings. In the electric furnace all the harmful effects of oxidation in the cupola are wiped away, making unnecessary as much manganese as formerly was needed. Excellent gray iron has been made by this process with much less than the 0.50 per cent manganese that has long been considered the lowest safe limit. Another benefit of the deoxidizing influence of the electric furnace is the absolute immunity of the manganese from loss during the iron's stay in the furnace.

Considering some of the other elements in cast iron we find that carbon may be reduced or increased at will. Ordinarily in an electric furnace free from rusted material it remains unchanged. Reduction of carbon is possible in two ways, by dilution with steel added in the electric furnace which should be the preferred method, and by the addition of predetermined but never very great amounts of iron ore or scale removing some of the carbon by oxidation. This last operation is familiar to steelmakers but for gray iron should be resorted to with caution. Dilution with steel especially furnishes an attractive method for the production of so-called semisteel of a quality and uniformity not possible by the old method in the cupola.

The element phosphorus in gray iron is not affected in the basic electric furnace. This is contrary to the belief of many who are more familiar with the dephosphorization of steel. Before gray iron could be dephosphorized, the bath would have to be reduced in carbon and silicon until it became a veritable steel; then by oxidation and removal of the slag the phosphorus could be removed, after which the carbon and silicon would have to be restored. Plainly dephosphorization of gray iron in the electric furnace is not economically possible. Like carbon however it can be reduced to a limited extent by dilution with steel.

Silicon in gray iron may be varied at will to suit the size and nature of the castings. It is controlled in the cupola phase in the usual way, and by making additions of ferrosilicon in the electric furnace.

The accompanying table gives at a glance the results obtained by duplexing several lots of gray iron. The last heat on the list is an exception being a heat of scrap metal that was melted from a cold charge in the electric furnace. Analyses and transverse strengths are given of the irons before and after going through the electric-furnace phase of the process. The transverse tests were made with the arbitration bar that is standard in the United States, the bar being 1¼ inch in diameter, 15 inches long and tested upon supports 12 inches apart. The interesting fact about the test is that the duplexed iron is uniformly stronger than the cupola iron, the average increase being about 33 per cent. Another interesting fact typical of a great number of heats, is shown in heat 2221 where a substantial addition of silicon made in the electric furnace was accompanied by an increase in strength that would be entirely unlooked for under ordinary conditions on account of the expected effect upon the combined carbon.

The cost of the electric furnace duplexing process for cast iron is difficult to discuss because there are many important factors that are extremely variable. Among these are size of furnace, cost of current, intensity of operation, degree of superheating and extent of refining necessary, and care and skill in operation. In the United States duplexing is being done at costs varying from 6 to 15 dollars per ton above the cost of ordinary cupola iron. Whether or not this added cost

Composition and Strength Compared

Heat No.		Carbon	Silicon	Manganese	Phosphorus	Sulphur	Transverse strength
	Cupola	3.48	1.92	.56	.53	.099	2812
1221	El. Fur.....	3.38	1.82	.61	.51	.022	4118
	Cupola	3.50	1.79	.54	.62	.158	2770
1281	El. Fur.....	3.22*	1.94†	.54	.61	.052	3985
	Cupola	3.35	1.91	.72	.59	.091	3748
6271	El. Fur.....	3.26	1.77	.73	.58	.018	5096
	Cupola	3.40	1.94	.42	.58	.069	3602
1721	El. Fur.....	3.41	2.21†	.44	.56	.026	4212
	Cupola	2.90	1.54	.43	.54	.151	....
8172	El. Fur.....	2.91	2.28†	.51††	.55	.013	4200
	Cupola	2.77	0.89	.24	.44	.160	....
8182	El. Fur.....	2.69	2.18†	.52††	.40	.057	5114
	Cupola	3.39	2.15	.77	.62	.057	2815
3419	El. Fur.....	3.14**	1.90	.84	.55**	.019	3824
	Cupola	3.45	1.83	.34	.48	.112	3316
2221	El. Fur.....	3.38	2.30†	.36	.47	.033	4022
1191	El. Fur. only	2.94	1.52	.62	.27	.009	4144

*Carbon reduced by mill scale in electric furnace.
**Carbon and phosphorus reduced by dilution with steel.
†Ferrosilicon added in electric furnace.
††Ferromanganese added in electric furnace.

is prohibitive depends upon the nature of the castings.

It is hardly necessary to say that for ordinary castings made upon a strictly competitive basis the duplexing process cannot compete with or displace the cupola process. However its use is feasible for extraordinary castings, for example those requiring unusual physical properties such as tenacity, solidity and most rigid freedom from all kinds of flaws. Its use is feasible for making of strong but highly nonfluid irons, castings that normally would be impossible for such irons. It also is economical for castings that are extremely expensive in every step of their production as also it is for castings that, although by nature liable to defects, cannot be inspected until after much costly machine work has been expended upon them. In short the duplex process is eligible wherever high quality or strong insurance against defective castings is desired. The time is not yet at hand to recommend the electric furnace for general castings under ordinary conditions, but only to suggest it as a highly efficient adjunct to the cupola for extraordinary castings and circumstances.

Before closing we must sound the warning that the electric furnace is not a cure-all for the many ailments to which the iron foundry is heir. Its adoption is not a surcease from all care, for if not attended by experienced and intelligent metallurgical supervision, it can readily become the source of the greatest worry and disappointment. Efficient and versatile as the electric furnace may be, it still is comparable to a highly developed machine that can be placed with assurance only in the hands of trained and intelligent operators. It needs the help of sound metallurgical sense, well directed thought and study, and at times of constructive imagination.

Will Make Arc Furnaces

Organized to manufacture and sell the repelling arc furnaces formerly made by the Industrial Electric Furnace Co., Chicago, the Re-Pel-Arc Furnace Co. has been established in headquarters at 227 East South street, Indianapolis. Branch offices are maintained in several larger cities and efforts now are being made to establish agencies abroad.

Faraday and Stodart published in 1820 a paper on the alloys of iron and steel. They made a rough qualitative test to show the grain by etching the metal with acid.

New Supply House Started

The Pennsylvania Foundry Supply Co., Liberty building, Philadelphia, has been organized to look after the special requirements of foundries. It will act as manufacturers, dealers and agents for all kinds of supplies and equipment such as are needed by foundries making ferrous and nonferrous castings. The company will specialize in furnishing supplies and equipment which most foundries use in large quantities and which they purchase in some respects from quality rather than price viewpoint.

The company is the eastern distributor of the Mac Co., Inc., Milwaukee, for their parting, high temperature furnace cement, brass cleaner and core compound. Warehouse facilities have been secured by the company in Philadelphia. H. E. Mandel, formerly of the Lindsay Chaplet & Mfg. Co., is general manager.

Builds Radiator Plant in Chicago

The Niagara Radiator & Boiler Co., North Tonawanda, N. Y., has bought 10 acres at Eighty-third street and Woodlawn avenue, Chicago, from Briggs & Turivas, scrap iron dealers, and will start at once the erection of a large plant. The first unit will be a warehouse, 140 x 475 feet.

Erects New Building

The Dodge Sales & Engineering Co., Mishawaka, Ind., is erecting a new building at 49 Park Place, New York. This building will occupy 165 feet on West Broadway, 50 feet on Murray street and 75 feet on Park Place. Present plans call for twelve stories, but foundation and construction will permit of an additional four stories if needed. It is the intention of the company to make this building a new center for the sale and distribution of factory and mill supplies for power and transmission purposes, including belting.

Top Blast Burns Iron

A heat of malleable iron can be ruined easily by too much top blast which will oxidize the metal and burn out a large percentage of silicon, manganese and carbon, especially the latter. Some foundrymen find that the amount of carbon in the metal decreases rapidly toward the end of the heat. This is invariably due to too high a top blast. At one foundry where the iron was losing a large percentage of carbon during the tapping period it was noticed that the top blast was directed down almost at right angles with the surface of the bath. The blast pipes were set at more of an angle so that the air had a better chance to mix with the incoming flame before striking the bath. Also the pressure of the top blast was changed. Instead of carrying a pressure of 7 ounces, or six inches, all through the heat, only 3½ ounces was used until after the first skim when 7 ounces was put on and the top blast was kept at this pressure until the metal became well heated when the pressure again was dropped to 3½ ounces. An analysis of the metal showed as follows:

	Sil.	Mang.	Carbon
After first skim ..	0.80	0.36	3.20
After second skim	0.67	0.32	3.00
Finished heat	0.62	0.18	2.70

With the first method of melting with the high-pressure top blast on during the entire heat it was difficult to get out a heat with more than 2.00 per cent carbon. The fact that with the new method the carbon in the final iron was 2.70 per cent would indicate that the trouble was with the top blast.

Opens Western Office

E. A. Keithley, Rialto building, San Francisco, representing the Central Foundry, Essex Foundry, Milwaukee Brass Mfg. Co., H. O. Canfield Co., G. M. Davis Regulator Co. and the Pittsburgh Valve Foundry & Construction Co., has opened offices in the Alaska building, Seattle. Mr. Keithley's son, E. L. Keithley has been appointed manager.

Questions Sand Quality

Question—We are buying a new supply of molding sand for gray iron castings and would like to know what its composition should be.

Answer—The quality of sand cannot be definitely determined by chemical analysis. Sands with widely different compositions are used in all countries. The average sand used in America for molds for gray iron would analyze: Quartz, 65 per cent; clay substance, 22 per cent, and feldspar, 13 per cent. A few of the larger foundries which have well equipped laboratories make mechanical and chemical tests of the sand they purchase, but for the small foundry perfectly satisfactory results may be attained by consulting any of the sand supply people and accepting their selection.

Design Electric Annealing Furnace

Malleable Iron Annealed With Electricity As Heat Source in 42 Hours—Iron-Carbon Diagrams Give Clue to the Reactions of Carbon in Iron Due To Heat Changes

BY C. E. CHANEY

ELECTRIC melting furnaces have made great progress in both the ferrous and nonferrous foundry but until recently little has been done with the electric annealing furnace in this field. Tests are now being made to determine the best means of applying electricity to annealing malleable iron. To determine the most efficient use of this heat to the annealing operation a clear knowledge of the nature of cast iron must be arrived at.

The Roberts-Austin, or carbon iron diagram* shows the form of the carbon in the iron at different temperatures.

In considering the behavior of carbon in pure iron on cooling from the molten state, *AB* and *BC* give the temperature at which for a given percentage of carbon, solidification begins, and *Aa*, *aB*, and *Bc*, that at which it ends, ignoring temporarily and for simplicity the fact that part of the carbon may exist in the form of graphite. But after solidification is complete and the metal has cooled to a much lower range of temperature, usually 900 to 600 degrees Cent., it undergoes a remarkable series of transformations. *GHSa* gives the temperature at which for any given percentage of carbon, these transformations begin, *PSP*[1] that at which they end. These freezing point curves thus divide the diagram into eight distinct regions, each with its own specific state or constitution of the metal: The molten state for region 1, and mixture of molten metal and of solid austenite for region 2; austenite alone for region 4, and so on. If the metal followed the laws of equilibrium, then whenever through change of temperature it entered a new region, it would forthwith adopt the constitution normal to that region. However, in fact the change of constitution often lags greatly so that the metal may have the constitution normal to a region higher than that which it is, or even a patchwork constitution, representing fragments of those of two or more regions It is by taking advantage of this lagging that thermal treatment causes such wonderful changes in the properties of the cold metal.

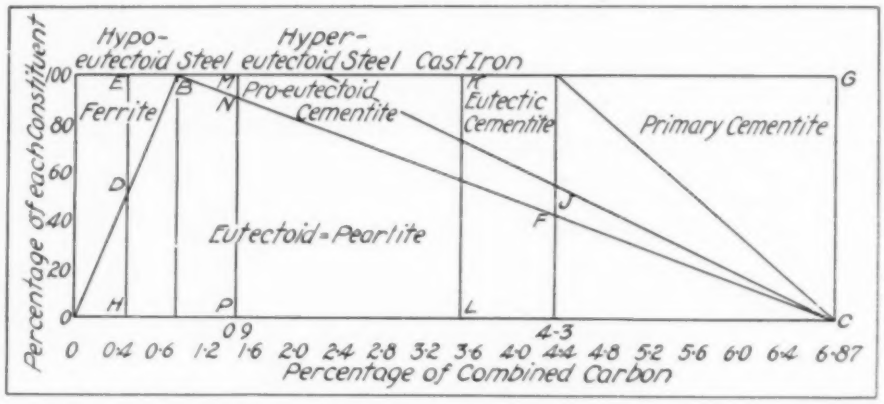


FIG. 2—RELATION BETWEEN THE CARBON CONTENT AND THE PERCENTAGE OF THE SEVERAL CONSTITUENTS OF SLOWLY COOLED STEEL AND WHITE IRON

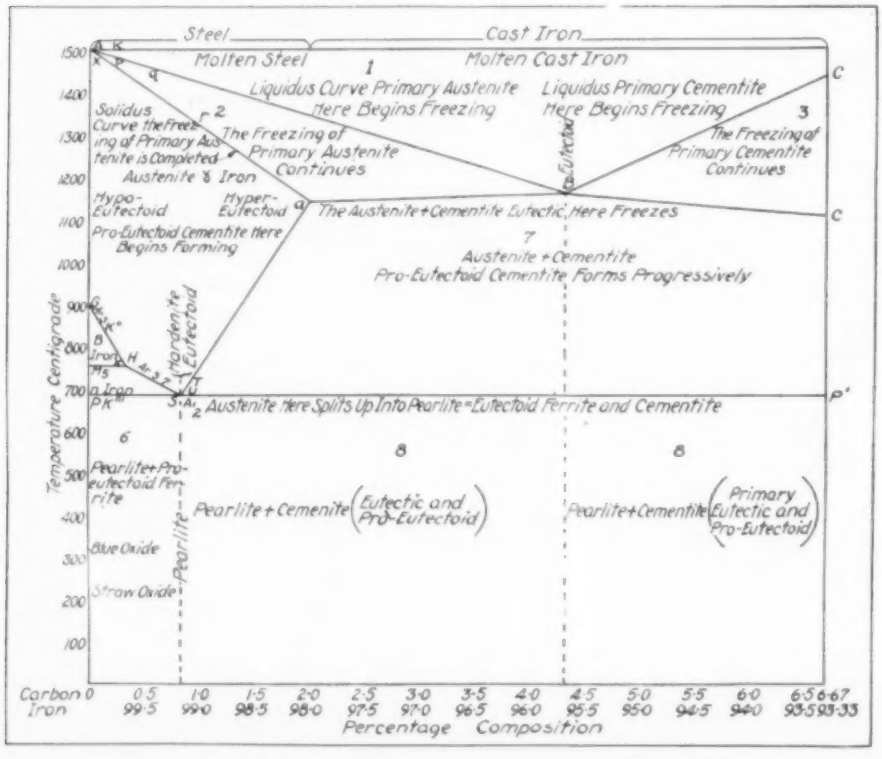

Steel
Cast Iron
Molten Steel
Molten Cast Iron
Liquidus Curve Primary Austenite Here Begins Freezing
Liquidus Primary Cementite Here Begins Freezing
Solidus Curve the freezing of Primary Austenite is Completed
The Freezing of Primary Austenite Continues
The Freezing of Primary Cementite Continues
Austenite & Iron
Hypo-Eutectoid
Hyper-Eutectoid
Pro-Eutectoid Cementite there Begins Forming
The Austenite+Cementite Eutectic Here Freezes
Austenite+Cementite
Pro-Eutectoid Cementite Forms Progressively
Austenite here Splits Up Into Pearlite=Eutectoid Ferrite and Cementite
Pearlite+Pro-eutectoid Ferrite
Pearlite+Cemenite (Eutectic and Pro-Eutectoid)
Pearlite+Cementite (Primary Eutectic and Pro-Eutectoid)
Blue Oxide
Straw Oxide
Pearlite
Temperature Centigrade
Carbon Iron
0 0·5 99·5 1·0 99·0 1·5 98·5 2·0 98·0 2·5 97·5 3·0 97·0 3·5 96·5 4·0 96·0 4·5 95·5 5·0 95·0 5·5 94·5 6·0 94·0 6·5 6·67 93·5 93·33
Percentage Composition

FIG. 1—ROBERTS-AUSTEN, OR IRON-CARBON DIAGRAM

Relation between the carbon content and the percentage of the several constituents of slowly cooled steel and white cast iron are shown in Fig 2.

Fig. 3 indicates physical properties and assumed microscopic constitution of the pearlite series. This figure shows how, as the carbon content rises from 0 to 4.5 per cent the percentage of the glass hard cementite, which is 15 times that of carbon itself, increases, and that of the soft copper-like ferrite falls, with consequent continuous increase of hardness and loss of malleableness and ductility. The tenacity or tensile strength increases until the carbon content reaches about 1.25 per cent and the cementite about 19 per cent. Then it falls. The presence of a small quantity of the hard cementite ought naturally to strengthen

The author, C. E. Chaney, is electrical engineer, Holcroft & Co., Detroit.

*Charts and references, Encyclopedia Britannica.

the mass by opposing the tendency of the soft ferrite to flow under any stress applied to it, but more cementite, by its brittleness, naturally weakens the mass, causing it to crack open under the distortion which stress inevitably causes.

Definitions of some of the terms used are:

Pearlite—A mechanical mixture of free alpha iron with iron carbide.

Cementite—The carbide of iron Fe_3C.

Graphite—Pure carbon in thin plates or flakes.

Temper Carbon—Free carbon in an amorphous condition.

White Cast Iron—Pearlite and cementite.

Gray Cast Iron—Pearlite and graphite.

Malleable Cast Iron—Ferrite and temper carbon.

Austenite—A form of iron carbide in iron unstable and indefinite in carbon content.

Ferrite—Theoretically pure iron and especially iron free from carbon.

Martensite, troosite, sorbite, etc.—Successive stages through which the metal passes in changing from austenite in cementite and pearlite.

The part played by graphite in the constitution of the iron carbon compounds hitherto ignored for simplicity, is shown in Fig. 4. In all these carbon-iron alloys, both steel and cast iron, part of the carbon may be dissolved in the iron usually as austenite (in regions 2, 4, 5, and 7 of Fig. 1). The carbon which is not dissolved forms either the definite carbide, cementite, Fe_3C, or exists in the free state as graphite.

Now just as Fig. 1 shows the constitution of these iron carbon alloys for all temperatures and all percentages of carbon when the undissolved carbon exists as cementite, so there is a diagram showing the constitution when all the undissolved carbon exists as graphite. The iron-graphite diagram is shown in Fig. 4, in unbroken lines, with the iron-cementite diagram produced in broken lines for comparison.

What here follows represents our present rather than any established theory. These two diagrams naturally have much

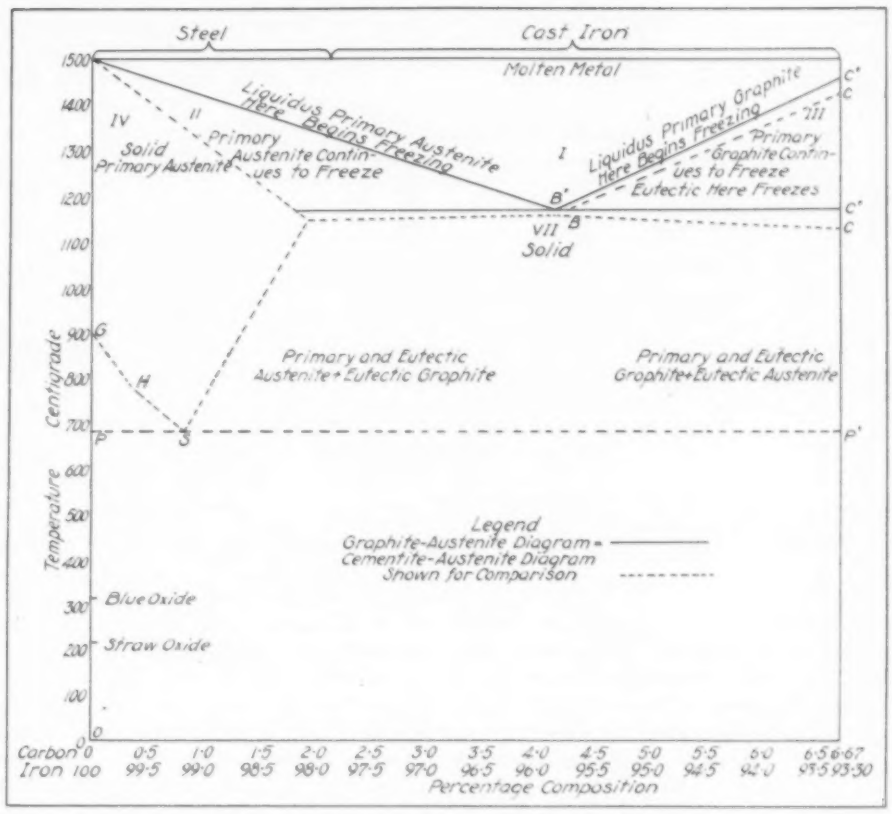


FIG. 4—GRAPHITE-AUSTENTITE OR STABLE IRON-CARBON DIAGRAM

the same general shape, but though the boundaries of the several regions in the iron cementite diagram are known fairly accurately, and though the relative positions of the boundaries of the two diagrams are probably about as here shown, the exact topography of the iron-graphite diagram is not yet shown. In it the normal constituents are, for region 2, molten metal plus primary austenite; for region 3, molten metal plus primary graphite; for region 4, primary austenite; for region 7, eutectic austenite, eutectic graphite and a quantity of proeutectic graphite which increases from the upper to the lower part of the region, together with primary austenite at the left of the eutectic point *B*, and primary graphite at the right of that point.

Thus when iron containing 2.5 per cent carbon solidifies, its carbon may form cementite following the cementite austenite diagram so that white cast iron results, or graphite following the graphite austenite diagram, or certain molecules may follow one diagram while the rest follow the other so that cast iron which has both cementite and graphite results. Though carbon passes far more readily under most condtions into the state of cementite than into that of graphite, yet of the two graphite is the more stable and cementite the less stable. Thus cementite is always tending to change over into graphite by the reaction $Fe_3C=3Fe+C$, or graphite. However, this tendency is often held in check by different causes. Graphite never changes directly into cementite, at least according to our present theory. But it may dissolve in the iron as austenite, and that when this later again breaks up it is likely to yield cementite. Then graphite is only an apparent and not a real exception to this law of the greater stability of graphite than of cementite.

Slow cooling, slow solidification, the presence and abundance of carbon, and the presence of silicon, all favor the formation of graphite. Rapid cooling, the presence of sulphur, and in most cases that of manganese favor the formation of cementite.

In making maleable iron the castings initially of white cast iron, are heated

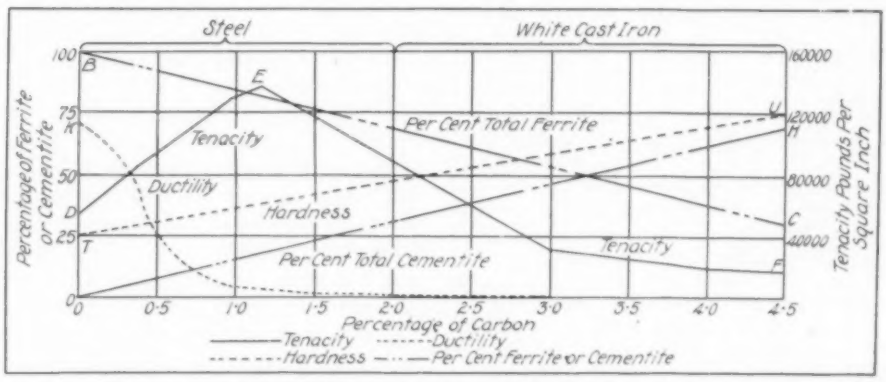


FIG. 3—PHYSICAL PROPERTIES AND ASSUMED MICROSCOPIC CONSTITUTION OF THE PEARLITE SERIES, GRAPHITELESS STEEL SLOWLY COOLED AND WHITE CAST IRON—BY "TOTAL FERRITE" IS MEANT BOTH THAT WHICH FORMS PART OF THE PEARLITE AND THAT WHICH IS IN EXCESS OF THE PEARLITE, AND SIMILARLY THE "TOTAL CEMENTITE"

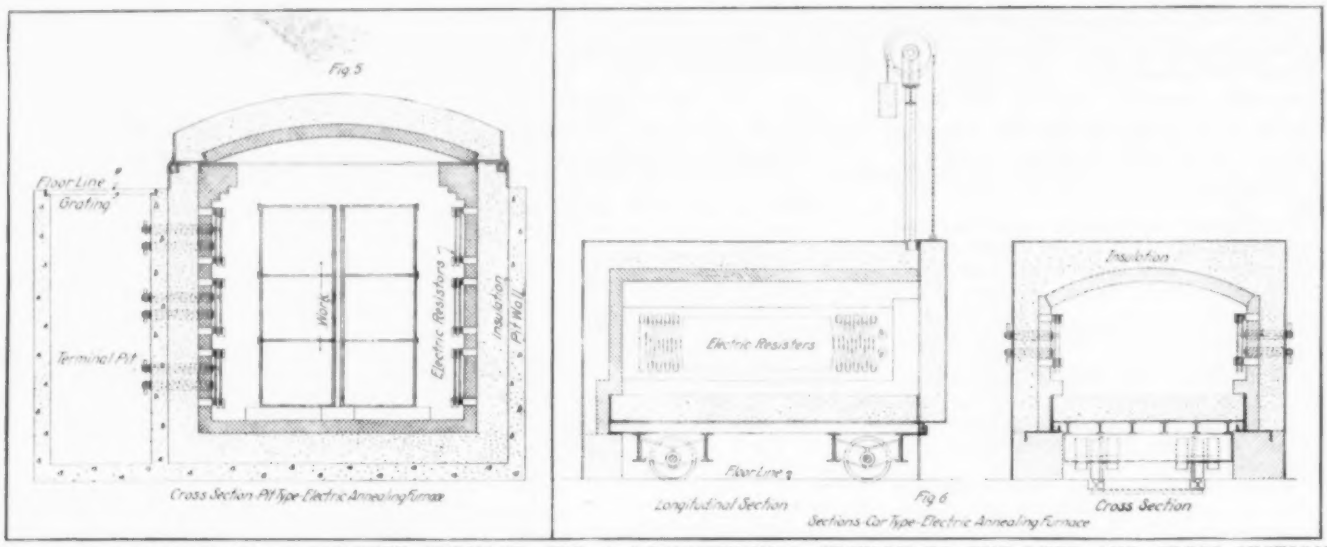


FIG. 5—CROSS SECTION OF PIT-TYPE FURNACE FIG. 6—LONGITUDINAL SECTION TO THE LEFT AND CROSS SECTION TO THE RIGHT OF CAR-TYPE ELECTRIC ANNEALING FURNACE

for several days to a temperature usually about 1350 degrees Fahr. and often reaching 1652 degrees. For about 60 hours the heat is held at its highest point, from which it cools extremely slowly. The molecular freedom which this high temperature gives enables the cementite to change gradually into a mixture of graphite and austenite with the result that, after castings have been cooled and the austenite has in cooling passed the recalesence point, changed into pearlite and ferrite, the mixture of cementite and pearlite of which they originally consisted has now given place to one of fine or *temper* graphite and ferrite, with more or less pearlite according to the completeness of the transfer of the carbon to the state of graphite.

Why, then, is this material malleable, though the common gray cast iron which is made up of about the same constituents and often in about the same proportion, is brittle? The reason is that the particles of temper graphite which are thus formed within the solid casting in its long annealing are so finely divided that they do not break up the continuity of the mass in a harmful way. In gray cast iron both the eutectic graphite formed in solidifying, and also the primary graphite which, in case the metal is hypereutectic, forms in cooling through region 3, Fig. 1, surrounded as it is by the still molten mother-metal out of which it is growing, form a nearly continuous skeleton of large flakes which break up the continuity of the mass of cast iron in which they are embedded.

Having followed the theory, the practical side of malleable-iron annealing now will be considered. The old style furnace used for annealing the past forty years consists of a box-type furnace heated by combustion of the fuel among containers holding the cast iron to be annealed. The burned gases are conducted out through flues to the stack, or a series of furnaces may be connected to the same stack by proper means of circulation. This leaves to the operator the responsibility of holding the temperature within a determined range. The process, with its irregular distribution of the flames of combustion, makes it necessary to fill the pots with packing to prevent oxidation. From investigations we have made it has been proved that the closer the regulation the better the product. To get the cementite to give up its carbon the temperature change should be uniform and steady. Therefore it was concluded in designing an electric annealing furnace that the following benefits could be obtained.

The control of the furnace should be such as to eliminate the personal element.

The temperature should be held with not more than 10 to 20 degrees variation.

The coming-up cycle should be as fast as possible under practical construction of a furnace.

The holding period should be the length of time necessary to give the maximum precipitation of carbon at the temperature reached.

The cooling period should be such as to precipitate the remaining carbon.

The opening temperature should be such as to produce scale-free castings.

The elimination of packing in pots, thereby reducing the raising period and increasing the heat penetration.

Uniform distribution of heat under a small temperature gradient.

The elimination of stacks, flues, stokers, coal, ash, gas and oil, thereby eliminating the circulation of large volumes of air so detrimental to the process.

The saving of heat by having the temperature of furnace walls never under 1200 degrees Fahr.

Labor saving devices by which the containers or pots can be removed or installed as rapidly as possible.

To design the furnace walls so that the heat through walls is as small as is practical.

Annealing tests with an electric furnace designed to meet the foregoing conditions showed that an iron within the following ranges of composition is fairly easy to anneal.

	Per Cent
Carbon	2.42 to 3.00
Silicon	.5 to 1.00
Manganese	.25 to .30
Phosphorus	.140 to .20
Sulphur	.05 or Less.

It was found that samples outside of this range caused more or less trouble in annealing. The castings were deposited in a container without packing and placed in an electric furnace which was then brought to 1600 degrees Fahr. and held until the maximum precipitation of carbon at this temperature had taken place. This was determined by withdrawing samples at intervals and making color determinations of the percentage of combined carbon contained. The samples were cooled by quenching. This set the structure of the iron so that it

Composition and Strength of Metal From 42-Hour Anneal

Hard iron.....	2.45	2.56	2.56	2.42	* Per cent carbon
	0.81	1.00	0.83	0.71	Per cent silicon
Annealed Casting	Trace*	Trace*	Trace*	Trace*	Per cent combined carbon
	X	X	X	X	Per cent silicon
Physical Properties	.635	.640	.640	.635	Dia. of test bar
	39,184	33,883	34,813	35,550	Yield point, lbs., per square inch
	54,763	47,802	53,010	58,558	Tensile strength, lbs., per sq. inch
	9%	7%	8.5%	8.5%	Elongation in 2 inches.

*Less than 0.05 per cent.

remained just as it came from the furnace. When the point was reached at which the carbon had attained its maximum precipitation or stability, we started to cool. The cooling rate depends on the percentage of cementite left in the castings. The data available on the precipitation of iron carbide to iron and temper carbon are very limited. Our research department is at the present time trying to establish some of this information. We have covered much of the field and from data now available feel sure that many of the malleable plants in the near future will produce malleable castings completely annealed on a production basis in from 50 to 70 hours for a complete cycle. The fact that the anneal can be accomplished in the electric furnace without packing and within a range of 10 to 15 degrees is of assistance in obtaining a quick anneal.

An anneal was made in the total time of 50 hours with iron having 2.42 per cent carbon, 0.71 per cent silicon. The castings were completely annealed without scale and showed good physical properties. Only a trace of carbon was left in the combined state. The metal had good bending qualities. Tests made on a bar 0.625 inches in diameter gave:

Yield point, 35,110 pounds per square inch.

Tensile strength, 52,323 pounds per square inch.

Elongation in 2-inch 24 per cent.

Reduction in area—10.3 per cent.

The accompanying table shows the properties of iron from another anneal totalling 42 hours. The iron was annealed in an electric furnace with bare thermocouples against the samples, so that the temperature might be controlled closely. Two types of electric annealing furnace have been designed by Holcroft & Co., Detroit. Fig. 5 shows the car-type furnace and Fig. 6 the pit-type.

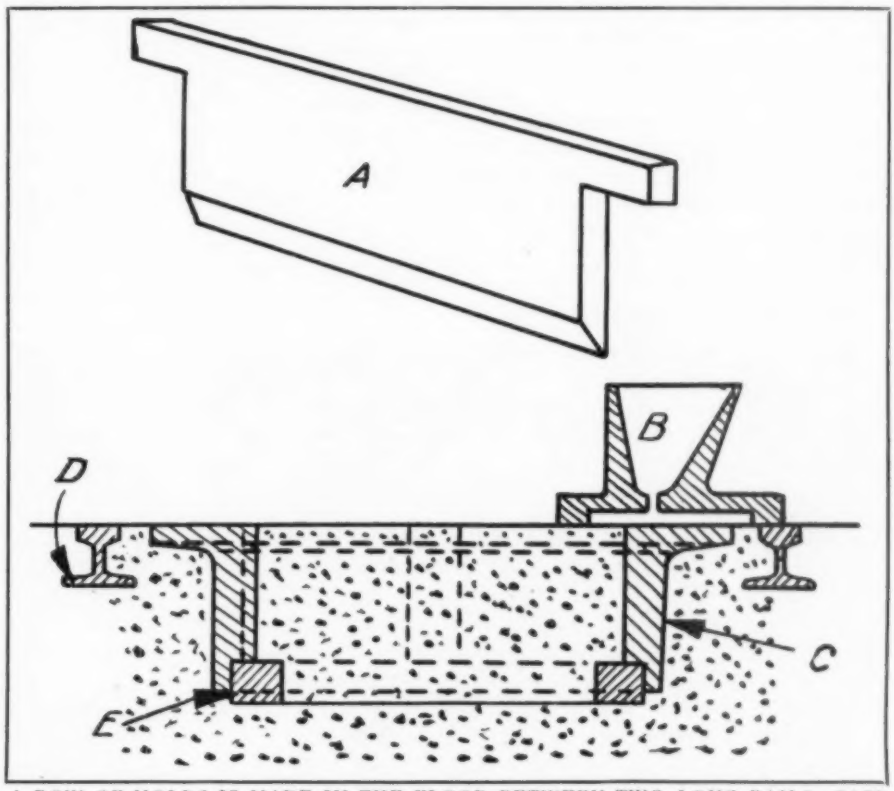
Sewer Rings Molded by Short Cut Method

BY F. E. McKANNA

ARTICLES have been published in THE FOUNDRY from time to time describing methods for molding and casting sewer rings. It is not my purpose to discuss these various methods, since apparently they were satisfactory to their sponsors, but in the accompanying illustration is shown a method which in my opinion is superior to any other I have seen. Among the advantages claimed are that no flasks are required and the molding process is so simplified that the castings can be made by apprentices or by unskilled labor. If only a limited number of castings are required one pattern will be sufficient, but usually it is an economical measure to provide two patterns.

Two long rails are bedded level and parallel far enough apart to provide 6 inches of sand between the pattern and the rails. The top surface of the rails may be flush with the foundry floor or an inch or two above it. After the rails have been adjusted the sand between them is dug out to a depth that will accommodate the pattern. For instance if the pattern is 12 inches deep the trench is dug to a depth of 15 inches. Sand passed through a ½-inch riddle is used to cover the bottom of the trench to a depth of about 4 inches. This sand is tramped off after which the scraper *A* is employed to scrape a flat, level bed on the bottom of the trench, 12 inches below the upper face of the rails.

The chill shown at *E* is used for making the shoulder in the bottom of the ring. It is much better than either green or dry sand and leaves a true, smooth seat for the cover. To provide for the contraction of the casting these chills may be made either in halves or in several segments. When made in halves the chill is cast as a whole circle with two thin splitting cores placed diametrically opposite each other. The space left by these cores is filled with green sand when the chills are in use and allows the chill to yield to the contraction of the casting. Chills made in several sections are provided with tapered ends which slide past each other when the contraction takes place. Two sets of chills rubbed with coal oil and plumbago are placed on the bed and then the two patterns are lowered on the top of them. Sand is shovelled and rammed around the pattern in the usual manner. It is tucked quite firmly around the bottom but not so hard under the top flange. Hard sand under the flange will cause the iron to boil and scab the mold. After striking off the joint the first pattern is drawn and set down on the far side of the second pattern. This sequence is repeated until the entire space between the rails has been utilized.



A ROW OF MOLDS IS MADE IN THE FLOOR BETWEEN TWO LONG RAILS CAST IRON CHILLS ARE EMPLOYED TO FORM THE SEAT FOR THE COVER

These castings can be poured in open sand, if necessary, but it is not much trouble to cover them, and the cover produces a much nicer casting. Two or three loam rings are provided about 4 inches larger in diameter than the

top of the casting. The loam ring can be lifted almost immediately after the casting has been poured and with a little touching up occasionally will last a long time. The runner box is made of thin sheet iron. It is daubed with clay like a hand ladle and the small hole in the bottom is set over a corresponding, but larger tapered hole, in the loam ring. The box and loam ring are provided with handles by which they can be shifted from one mold to another. In the event that a large number of molds are ready it is advisable to provide several runner boxes to prevent delays. This type of runner is to be preferred to the ordinary runner core which requires the time of a coremaker besides the cost of sand, binder and drying. The core only can be used once, and the time of a helper is required to gather them up after the cast and wheel them to the dump and a certain proportion invariably get broken and find their way into the molding sand.

A cheap iron mixture and yet one that produces clean, strong castings is composed of 20 per cent pig iron, 50 per cent scrap and 30 per cent steel scrap.

Correcting Flaws in Metals and Mixes

Problems of the Gray-Iron, Malleable and Steel Foundry Discussed

By H. E. Diller

Remelting Benefits Iron

Question—Is any advantage gained by adding gray-iron scrap to a charge in a cupola, or is an all-pig charge just as good?

Answer—It generally is conceded that a percentage of scrap iron added to the charge in the cupola benefits the metal. Probably the main cause of this is in the regulation of the carbon. Also, all-pig charge would be apt to contain an excess of carbon which would cause internal shrinkage and a coarse grain. Each time the iron is remelted the carbon content comes more to an equilibrium and the metal is benefited by remelting until an excess of oxygen or sulphur is taken up by the iron.

Melting Crucible Steel

Question: I have tried unsuccessfully to melt steel punchings in a brass furnace using a plumbago crucible and the best Scotch coke. The furnace is 16 inches in diameter, the depth of the ash pit is 15 inches and the furnace flue is three feet above the grate bars. The crucible which was used is 8¼ inches high. It is kept about 5 inches off the grate bars by a fire block on which it is placed. I would like to know how to melt the steel and the probable time it will take to melt 560 pounds of steel. The castings required are for light agricultural work. Would it be necessary to anneal them and, if so, how should it be done?

Answer: In order to melt steel you should use a regular steelmaking crucible and have the melting stock of approximately the same carbon content as it is desired to have the finished castings. The crucible should be placed so that it is entirely surrounded—top, bottom and sides—with white hot coke. In order to keep the body of coke at a white heat the space between the crucible and the side walls of the furnace should be greater than you now have. You should make the furnace 18 to 19 inches in diameter which would give you 2 or 3 inches more depth of coke around the crucible. Should the draft of your chimney not be strong enough, try a forced draft.

It probably will require 5 to 6 hours to get the steel sufficiently hot for pouring and from this knowing the weight of metal in the crucible you can calculate how long it would require to melt any specific amount of steel.

It would be impossible to say whether the castings should be annealed without knowing their shape and the specific purpose for which they are to be used. Almost any casting would be benefited by annealing, and the determining factor would be whether the work to which the casting is to be put is important enough to warrant the added expense of annealing. The anneal would soften the castings somewhat, relieve internal strains and make them less brittle. To anneal the castings, they should be heated to 820 degrees Cent. and held at this temperature for an hour or two, then cooled slowly. Should you desire to prevent oxidization of the surface of the castings they should be placed in a cast-iron box or a steel pipe with a little charcoal. The receptacle should then be sealed with fire clay.

Pouring Steel Castings

Question—Will you please advise whether it is good steel foundry practice to pour light steel castings, weighing from ¾ to 25 pounds, with a 3-ton bottom-pour ladle instead of with small shank ladles as is the usual custom?

Answer—The molds could be poured with a bottom-pour ladle, but it is better practice to either catch the metal from the furnace in shank ladles or to pour from the furnace into a tea-pot ladle and shank-off from this.

Carbon Burned Out of Malleable Iron

Question—Please tell me how to raise the carbon content of malleable iron from 2.00 to 2.50 per cent without using more pig iron in the charge. I now am charging 4800 pounds pig iron, 5000 pounds old annealing pots and 100 pounds of lump coke. With this composition my carbons run around 2.00 per cent. I also would like to know how to remedy over-annealed iron.

Answer—The best way to raise the carbon in the malleable iron bath without increasing the amount of pig iron would be to put either coke or possibly coal on the bottom of your furnace before charging. The carbon then would unite with the iron after the iron on the bottom had been melted. Carbon will not unite readily with iron unless the iron is at a high temperature. At the temperature at which steel is poured the carbon of coke will combine.

However, it should not be necessary to raise the carbon, as you should secure 2.50 per cent carbon from your original charge of metal. It would seem that your trouble is due to the use of old annealing pots. These pots are practically iron oxide and you might as well use iron ore. The oxygen of the iron oxide combines with the carbon and silicon in your metal and reduces the amount of both. This is quite expensive, especially the reduction of iron oxide with silicon.

There is no practical way in which you can bring back over-annealed malleable iron. The statement in regard to the character of your charge and the composition of the iron, indicates that your trouble is not with over-annealed iron but with the iron having too low carbon content. Iron which comes from the furnace with less than 2 per cent total carbon is apt to show a white fracture after annealing.

Operating A Pipe Fittings Foundry

Green-Sand Cores used for the Larger Fittings—Novel Method of Handling Dry-Sand Cores—Convenient Arrangements of Tracks in the Pig Iron Storage Yard

EQUIPMENT forms such a complicated problem that the design of a foundry is of great interest, each installation presenting different problems from all which go before. Interesting as may be the features of construction, the way the assembled mechanism operates is of more vital importance to the foundry executive. Therefore, operating features of the new foundry of the General Fire Extinguisher Co. described in the Sept. 1 issue of THE FOUNDRY are presented. This shop now has been operating more than two months and all the minor imperfections are well ironed out of the system. Little trouble was encountered in starting this plant; less, in fact, than usually is experienced with a new shop, because the management has been operating similar foundries and is thoroughly familiar with the conditions met.

THE article describing the foundry of the General Fire Extinguisher Co., which appeared in the Sept. 1 issue of THE FOUNDRY *detailed the construction of this remarkable plant. However, it was written before the shop was in operation and therefore nothing was available concerning actual operating details. The plant is so well laid out and so efficiently operated that a brief description of operating features is here offered.*

The care taken in designing the plant has been followed in all details of its operation. To insure uniformity of metal from one end of the heat to the other, and from one day to the next, every car of pig iron received is piled on a separate pile, and later is sampled, and the drillings are analyzed before the metal is used. Each carload is piled along one side of an industrial track a number of which are laid parallel, extending from the building to an industrial transfer track shown in Fig. 4. In this way the two men who bring all the pig iron and coke to the cupola can run one of the dump cars, used for carrying the pig iron, to any pile. The tracks slope slightly toward the transfer car. Therefore, the filled dump cars which have a capacity of 2000 pounds easily are moved to the transfer car. The latter are operated through a controller, shown at the left. A foot brake enables the operator to stop the car instantly, to match the rails of the car with those on the ground.

Only one kind of pig iron at a time is put on the dump car and the charge is weighed on the cupola floor as explained in the previous article. Time is saved, in getting the iron to the charging floor, by the automatic control of the elevator. The stock men place the car on the elevator, close the doors, then push a button and the car travels to the charging floor where it is taken from the elevator by the attendants weighing the charges. The control is so designed that if any of the doors are open the elevator will not move. When the elevator approaches the stopping place a leveling device comes into action and brings the platform even with the floor at which the stop is made.

One of the cupolas is lined to 54 inches inside diameter and the other to 72 inches. When the foundry is operated with continuous pouring, as it will be when the demand for castings become normal, the cupolas will be operated on alternate days, but now the smaller one commonly is used. The charges which weigh 2000

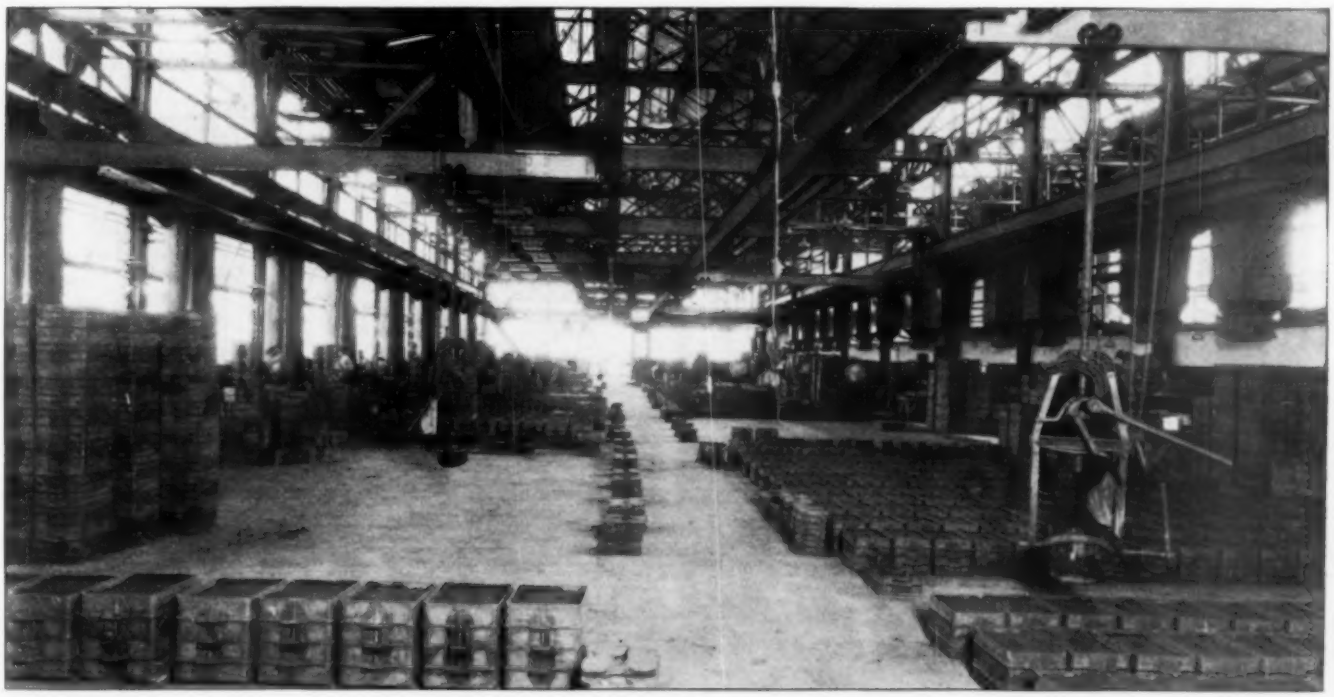


FIG. 1—THE MOLDING IS DONE ON THE SECOND FLOOR OF A WELL LIGHTED AND VENTILATED BUILDING—METAL IS CARRIED TO THE MOLDING FLOORS IN LADLES TRAVELING ON MONORAIL CARRIERS

FIG. 2—THE CUPOLA TAP HOLE IS NOT CLOSED DURING THE HEAT—THE METAL FLOWS INTO A MIXING LADLE

pounds, are calculated by the foundry superintendent, Nelson Johnson, from the composition of the pig iron. All of the home scrap and sprue is used in the mixture, but no scrap is purchased. The iron commonly used ranges from 2.40 to 2.60 per cent silicon, 0.5 to 0.6 per cent phosphorus, and around 0.6 per cent manganese. The sulphur is kept as low as possible. Not only is the composition of the iron closely watched, but transverse check tests of 1-inch bars are made every day.

The cupola is lighted by a fuel oil burner manufactured by the Hauck Mfg. Co., Brooklyn. This burner may be seen to the left in Fig. 2. After the tapping spout is first opened, it is left open during the entire heat. The metal is caught in a tipping ladle with a spout at the bottom. In this way all the slag and impurities which come with the molten iron

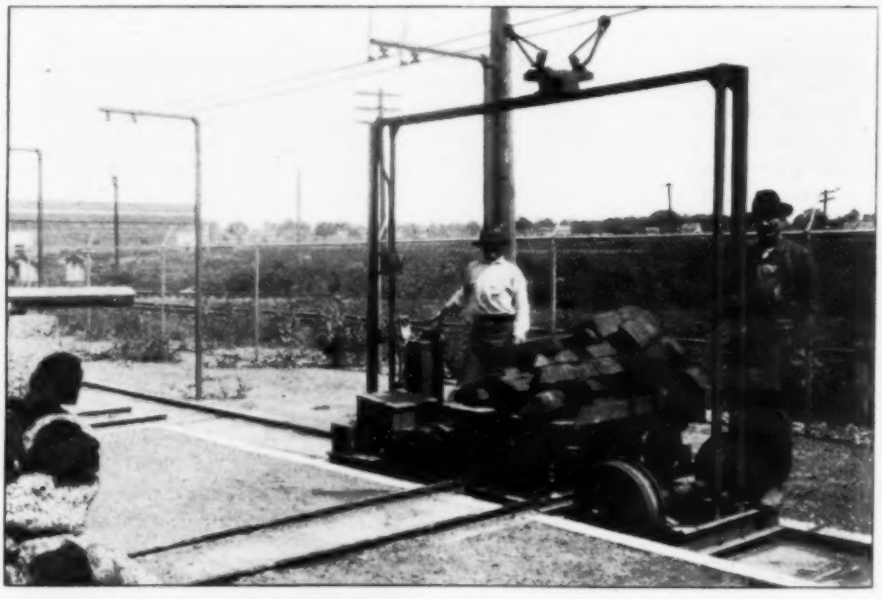


FIG. 4—PIG IRON IS UNLOADED ALONG THE SHORT INDUSTRIAL TRACKS

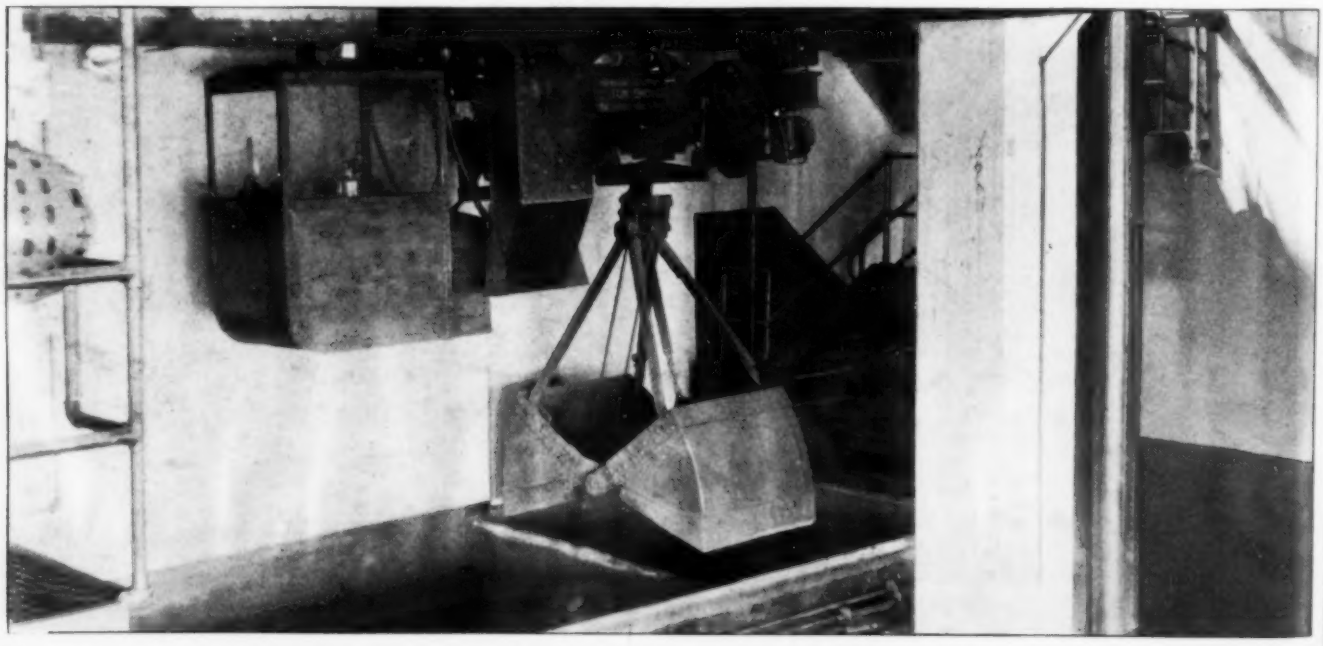


FIG. 3—SAND IS CARRIED FROM THE STORAGE BINS TO A LONG BIN UNDERNEATH THE MOLDING FLOORS WHERE IT IS MIXED WITH THE USED SAND WHICH FALLS THROUGH CHUTES

are caught in the mixing ladle and do not reach the pouring ladles. The pouring hole of the mixing ladle is never closed, but the ladle is tilted back when it is desired to stop the flow of metal. The steel platform, built of pipe with steel plate, shown in front of the ladle, Fig. 2, is used by the cupola tender. The tap hole of the cupola is kept free by the use of a steel bar thrust through the hole shown in front of the ladle. The cupola is slagged from the rear in the usual way, limestone being used as a flux to thin the slag and cause it to run freely. The slag falls through a hole in the floor directly under the cupola and of approximately the same diameter. The drop from the cupola also falls through this hole and is deposited in a room beneath, directly beside the water mill. A steel beam across the hole and anchored in the floor serves to support the bar which holds the bottom doors when they are closed.

FIG. 6—SAND IS DROPPED FROM OVERHEAD HOPPERS TO THE MOLD

FIG. 5—CASTINGS ARE DROPPED DOWN CHUTES FROM THE MOLDING FLOOR

Metal is caught in 1000-pound ladles carried on a monorail. This monorail system consists of parallel rails extending the length of the shop in the center, as indicated in Fig. 1. These rails are connected at both ends by a wide loop so that the ladle may be carried down one side and back the other. The loop at the one end passes in front of the cupola. Metal is poured from the carrying ladle to smaller ladles carried over the molding floors by traveling I-beam cranes. One of these ladles is clearly indicated to the right in Fig. 1. Every ladle used in the shop is equipped with a skimming attachment. Practically all the molds are poured in steel flasks made by the Sterling Wheelbarrow Co., Milwaukee, Wis. However, wooden flasks sometimes are used for new jobs which have not been standardized.

Castings are dumped out shortly after being poured and are dropped down chutes to the floor below, landing against a baffle placed under each chute, and near a tumbling barrel. When not in use, the chutes are closed by a steel cover. One of the chutes is shown in Fig. 5 with the baffle beneath it. These baffles are made of six sections of steel rail, bent at right angles and having one end bent over for a short distance. A steel plate is attached to the rails at the bottom and another plate is suspended from the ends of the rails which are bent over, being anchored to the rails at the bottom. Castings

FIG. 7—USED SAND IS DROPPED THROUGH CHUTES TO A LONG BIN WHERE IT IS GIVEN A PRELIMINARY WETTING

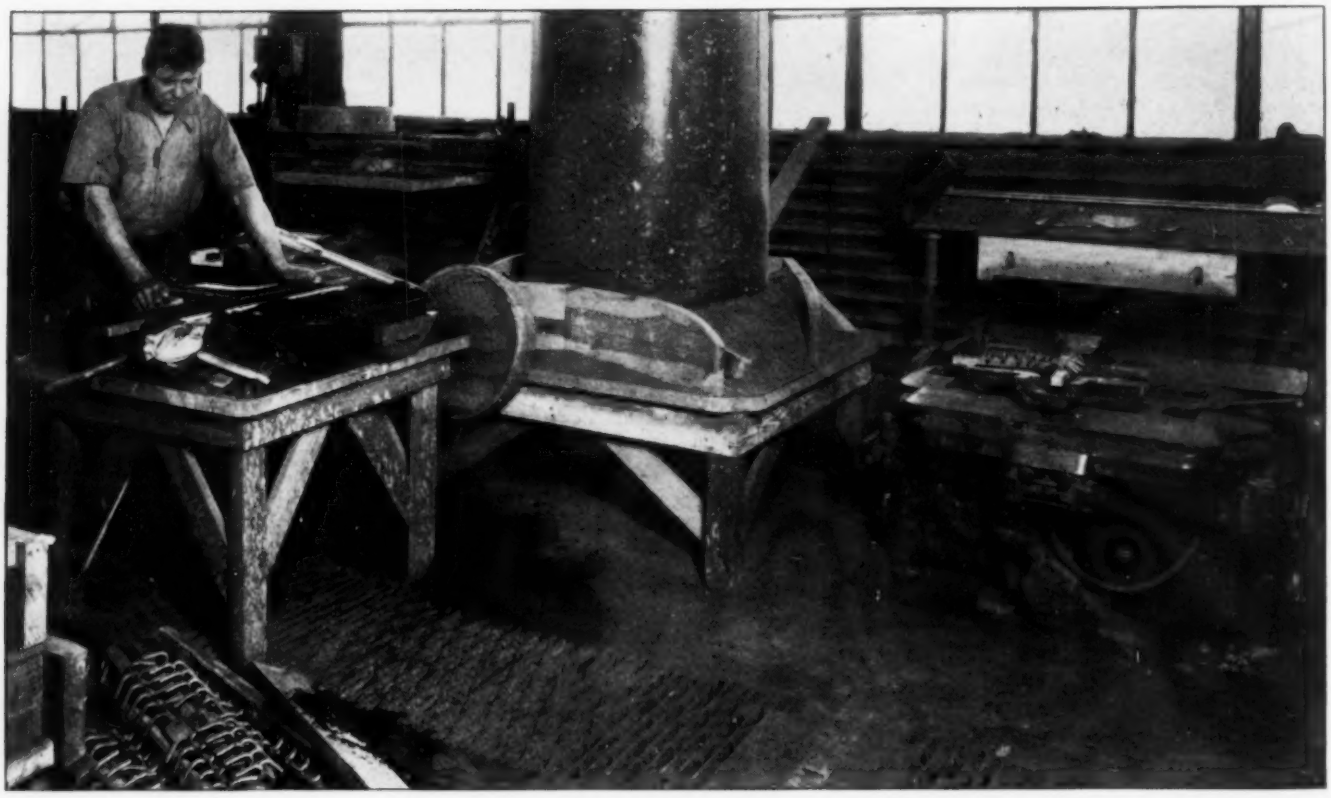


FIG. 8—CORES FOR THE LARGER FITTINGS ARE MADE OF GREEN SAND—THE MOLDS ARE MADE ON JOLT-SQUEEZE-DRAW MACHINES, ONE OF WHICH MAY BE NOTED ON EACH SIDE OF THE SAND CHUTE

then can be forked from the baffle to the tumbling barrel, and after being tumbled are placed in steel drums to be taken to the grinding room by the telpher traveling on the monorail system which extends through the lower floor. In the illustration of the barrel, Fig. 5 may be noted the chain lift used to take the cover from the barrel, and the gate *A* which is always closed before the barrel is started to revolve. This gate is made entirely of light pipe and fittings and is easily raised, sliding on two upright pipes. The cores to a great extent remain in the castings until tumbled. Therefore, a large amount of sand must be removed during this operation. This is drawn out through an exhaust system into a dust arrester outside the building, over the railroad track from where it is dropped into cars to be carried to the dump.

When the castings reach the grinding room they are dumped on sorting benches where they are inspected and placed in wooden trays carried on wheels, the correct height to allow a man to pick up the casting without stooping. The trays are of such width that they fit between the grinders. From the grinders, the castings are

FIG. 9—THE CORE IS CARRIED TO THE MOLD BY TWO MEN HOLDING TO THE THREE ENDS OF THE ARBOR FIG. 10—THE CORE IS RESTING IN THE DRAG WITH THE COPE READY TO CLOSE THE MOLD

carried by the monorail system to the scale with a counting attachment in the shipping department where they are weighed. The drum in which the castings are weighed is then picked up by the telpher and loaded on a truck. No castings are stored in the foundry.

Louver Doors Used

The sand system as described in the previous article has been found to give good satisfaction. Three men unload a hopper car of sand and get it to the bin in approximately 1 hour. The louver doors formed by sliding boards in inclined notches, have proved convenient at the openings of the sand bins. By means of these, the opening of the bin is always kept level with the sand which can be shoveled out easily into the telpher bucket which carries it to the mixing bin. This bin, situated along the outside wall on both sides of the foundry, is formed by the foundry wall and a low concrete wall as indicated in Fig. 7. The illustration shows the sand chutes above to the left and the chutes for the castings may be noted at the right. The sand which falls from the molding floors is given a preliminary wetting and any new sand needed is mixed with it before it is carried to the hopper at the end by the telepher, shown in Fig. 3. The sand then is screened and elevated to the milling machine from whence it passes to the storage hoppers, as described. From the main storage hoppers it is wheeled to the hoppers of the individual molders. One man on each side of the shop is able to keep the molder's hoppers filled.

FIG. 12—THE CORE IS CARRIED TO THE MOLD WITH A LIFTING PIN WHICH SCREWS INTO THE ARBOR

FIG. 11—THE MEDIUM SIZE CORES ARE MADE OF GREEN SAND USING PRONGED ARBORS OF CAST IRON

As previously noted molds requiring dry-sand cores are made on the side of the foundry next to the core room and those in which green-sand cores can be used are molded on the opposite side. Molds requiring dry-sand cores are for the smaller castings and are made on the jolt, squeeze pattern-draw machines, furnished by the Wm. H. Nicholls Co., Brooklyn. A few of the 31 machines secured from this company also are located on the opposite side of the foundry, together with two rollover, jolt, draw, one plain jolt and four squeeze, draw, stripping plate machines built by the Osborne Mfg. Co., Cleveland.

One of the machines located on the side of the foundry where dry-sand cores are used, is shown in Fig. 6. This illustrates the methods of dropping the sand from overhead chutes, although in this case the gate has been held open too long and dropped more sand than is customary. The opening through which cores are received from the core room is shown at *A*. One of these openings is located between each two

machines. The cores are transported in wooden boxes 24 x 12 inches by 6 inches high. These boxes, as may be noted from the one illustrated at *B*, Fig. 6, are open at the one side and have one strip of board across the top in the front and one at the back. The boxes are carried by two wooden cleats, one of which is nailed across each end, sloping out from the bottom upward. These tend to prevent the boxes from tipping away from the person carrying them. When the molder empties a box, he passes it back to the core room through the window from which he has received it.

The drags and copes usually are made from the same pattern, the large majority of which are on cast-iron plates. The only difference between the two is the gate and runners which are cut into the sand. The molds, being set in long rows, it has been found more convenient to first make a full row of drags and then make the copes.

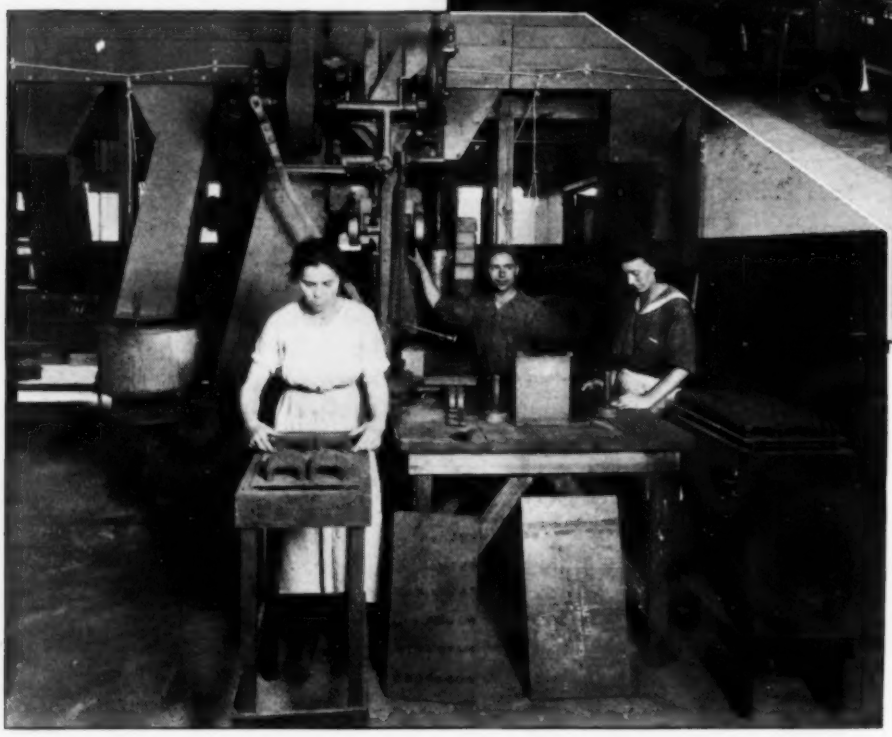


FIG. 13—ONE MAN BLOWS THE CORES WHILE TWO GIRLS TAKE THEM FROM THE BOXES AND PLACE THEM ON PLATES

From long experience the General Fire Extinguisher Co., has found it more economical to make the larger cores of green sand than to make them with dry sand. The large volume of this work made in the company's foundries has induced the company to do a great deal of experimental work on green sand molds and its methods therefore are extremely interesting. Fig. 8 shows a green-sand core for a 6-inch long urn *T* being molded. For this a hinged core box of cast iron is used. A little parting sand first is shaken on the box from a bag; then facing sand is sifted over the box and used sand is shoveled in until the box is approximately half full. The arbor after being wet with clay wash, is inserted. This arbor consists of two cast-iron bars into which pieces of steel rod bent at right angles have been cast. These pieces of steel rod act as fingers to support the sand. The long bar extends across the box and rests in notches, one of which is in the center of each end section of the box. The second bar of the arbor fits into a square hole in the cross bar and rests on a notch placed in the end of the box at the outlet side. A nail is placed in the angle of the core and the box is filled with sand and rammed. After striking off the core the molder vents it with a wire and cuts out vent lines in the one half, opposite to the arbor. The box is closed, lifting both sides until it stands with the outlet up. The box then is set on its side with the drag up. This is raised and the core is slicked. The box is again closed and rolled over so that the cope side may be raised and the core slicked. It is then ready to be taken from the mold which is done by two men as shown in Fig. 9. One man lifts by one end of the cross bar while the other workman takes hold of the opposite end of the cross bar and the third end of the arbor.

FIG. 14—GIRLS MAKE CORES AT BENCHES AND PLACE THEM ON RACKS

The mold in which this core is used is illustrated in Fig. 10, with a core in place. It is molded on a jolt-squeeze-draw machine, one of which may be seen to the right in Fig. 8. This also illustrates the method of handling sand used on this side of the foundry. Sand is shoveled from the openings on both sides at the bottom of the chute, thus one chute serves two molding machines.

Facing sand is used on these larger molds. Wooden pins or *soldiers* are placed in the first shallow layer of sand added and the mold is filled with sand and jolted, then squeezed. The pattern is vibrated and the mold raised. The flasks on this job are 20 x 25 inches; the cope being 9 inches deep and the drag 8 inches. The mold is poured from one down gate at the bottom of which a strainer core is placed.

The mold for the 6 x 6 x 3-inch *T* is made on a smaller machine of the same type as the one used for the 6-inch long *T*. The flask is 13 x 16 inches, with a 6-inch drag and

a 7½-inch cope. A light cast-iron pronged arbor is used for making the green-sand core. A lifting pin is screwed into the arbor and after it is wet with clay wash it is laid in the core box which is then clamped together and placed on end. Sand is rammed in the box and a nail is inserted in the section of the core for the outlet. The box is next turned and the sand rammed from the opposite end. After the cope side is vented, with a vent wire, the box is turned on its side and the cope section is removed as indicated in Fig. 11. The core is then carried by the lifting pin and set in the drag section of the mold as indicated in Fig. 12. The gate cut in the drag may be noted to the molder's right. After the lifting pin has been screwed out a small dry-sand core is inserted in the hole which is left by it.

Cores are made on the two blowing machines described in the previous article and on benches. One of the blowing machines is shown in Fig. 13. A boy operates the machine, blowing two double cores at a time and handing the box to one of the two girls who sets the cores on trays and returns the corebox after cleaning it. The gallery over which the core sand is wheeled may be noted in the upper section of the illustration. The chute delivering sand to this machine is shown at the left. The sand is carried automatically to a hopper at the top of the machine and blown into the core boxes.

Carry Core Plates Between Benches

A section of the coreroom where the cores are made at benches is shown in Fig. 14. A cord attached to a gong is located at every bench so if any girl wants plates or sand, or to have the cores carried away she can attract attention. A space is left between the benches for carrying core plates, as indicated at *A*, Fig. 14. All core plates are perforated steel and were made by the Truscon Steel Co., Youngstown, O. The cores either are placed on racks, such as is shown behind the benches in Fig. 14, or the plates are carried to the drawer type ovens. The racks are carried to the ovens by lift trucks. The coreroom is equipped with three rack-type ovens, each holding two racks, and three of the drawer type. No racks are used for storing the cores, but after they are taken from the oven they are placed in the boxes already described. The boxes are placed in stacks along the wall, near the window opening onto the floor on which the cores are to be used. This system cuts down the amount of handling required and also furnishes indications of the supply of cores on hand. If the foreman of the core department sees a window by which no cores are stacked, he knows at once that cores are needed at that place. All coreboxes are stored in a rack at the end of the coreroom and when an order for cores is received it is placed in the corebox which is then ready to go to the coremaker. Almost all of the patterns are plate patterns and are kept in the pattern storage in racks fitted with grooves into which the plates slide. An assortment of sweeps is kept in the pattern storage to be used for the occasional order of a few odd sized fittings.

Pouring Temperature Affects Shrinkage

BY R. R. CLARKE

THIS discussion chiefly concerns those castings in which bulk is heavy or variable or the ratio of volume to surface high. Examples are a 6-inch cube, a 5-inch pin brass 12 inches long, a valve body, a flanged bushing, etc. In using the word shrinkage we observe the sense of drawing, sinking or receding of metal at its highest or heaviest casting vicinities or between the variables of bulk where the shrinkage is unusually strong and exceedingly local.

Briefly this paper proposes to show that:

1. Shrinkage decreases as temperature rises. 2. Cleanliness and compactness advance with temperature. 3. A closely defined and dangerous limit intercepts a rising temperature, marking the activity of gases and oxides and making for a most distressing condition in the castings. 4. Hot pouring necessitates molding with that end in view to avoid many difficulties.

That shrinkage should decrease with temperature is an apparent contradiction, since expansion's law is to advance with temperature and measure a corresponding contraction in return to normal. No doubt the explanation rests in part at least on the greater fluidity enabling the metal to generate and transmit higher gate pressure, run the mold more searchingly and establish and maintain better communication between its parts.

The primary advantage of hot pouring is a clean, solid, unshrunken casting realized through a comparatively small gate easily removed. Instances could be cited where a change of gating practice and pouring temperature reduced the gate metal from 100 pounds to 20 pounds and cut down cleaning time and expense, melting loss, etc., correspondingly.

Additional advantages are the suppression of the hair line fracture, of gate pin holes, and the nullified effect of molding inconsistence to which cold metal is so peculiarly sensitive. Cold metal rebels against a hard cope or damp core and solidifies, preserving the effect. Hot metal contends against the conditions and often prolongs fluidity beyond the activity of cause.

The hair line fracture is a modified form of recession due to unequal contraction and intensifying with erratic molding such as wet sand, hard ramming, sparse venting, etc. By our experience it seldom seriously attends hot pouring but to greater or less degree always emphasizes cold pouring.

A hot metal mold requires sand rather dry, rammed hard, faced well, vented freely and clamped or weighted securely in pouring. Similar precautions should be taken against the burning in of cores.

The author's experience inclines to the belief that within certain limitations there is a suggestion of identity between the running capacity of metal in light thin castings and its power to resist shrinkage in bulky castings or variables between volume; that the ability of metal at proper temperature to run a thin gate and light casting is at least an indication of its adaptability at the same temperature to run through the same gate to a clean, solid, unshrunken bulky casting. Both experience and experiment contribute to this inference under certain limitations as previously stated.

The relation of hot pouring to solid castings applies more directly to the more common copper-tin, copper-tin-lead and copper-tin-lead-zinc alloys as 90 copper, 10 tin; 88 copper, 10 tin, 2 zinc; 80 copper, 10 tin, 10 lead; 85 copper, 5 tin, 5 lead, 5 zinc, and weakens in those metals and combinations an unusually high contractive tendency. Among these are pure copper, monel metal, yellow brass, manganese bronze, aluminum bronze, tobin bronze, muntz metal and other high zinc mixes. A further striking feature of shrinkage

From a paper presented before the Columbus convention of the American Foundrymen's association.

is that new metals or combinations on first melting shrink more perceptibly than on subsequent occasions. Metal melted and pigged and then remelted and cast or that representing part new, part remelt will usually express shrinkage less than all new metal cast on first melting.

High pouring temperatures are critical chiefly because of extreme oxidation and the occlusion and expulsion of gases resulting in porosity. They therefore call for extreme caution and expert knowledge on the part of the melter. Beyond the danger line metal sometimes has a curdled-milk appearance, sometimes a dull-colored surface crust and sometimes a wicked looking exhibition of the varying colors arising from the different constituents such as tin, lead, etc. Another phenomena is a spattering or crackling sound as that of boiling slag. Metal at such a temperature will often appear mushy and cold and consequently deceiving as to its temperature when judged solely on its appearance of fluidity. These are dangers we might state encountered mostly in air and oil melting. On the other hand, cold pouring by virtue of low fluidity weakens cohesion, strengthens metals' power to hold and include its dirt and dross and denies that gate pressure due to hydrostatic principles .

Many actual cases could be cited in proof of these arguments, among them the casting of heavy valve bodies, trolley wheels, heavy pin brasses, large bushings, heavy gear wheels, brazing flanges, pressure castings and many others.

In concluding, the author expresses his regret at being unable to furnish pyrometric rather than mere judgement values on the temperatures to which he has made reference throughout feeling that such definite information would greatly increase the value of his remarks.

How and Why in Brass Founding

By Charles Vickers

Aluminum Alloy Porous

We are trying to make large aluminum castings that have to withstand 150 pounds water pressure. With a 7/16-inch wall they weigh 30 pounds each. We are using No. 12 ingot metal and are getting fine looking castings but under pressure they leak as if the metal was porous. What can we do to make them withstand this pressure?

The No. 12 alloy is unsuited for castings that have to withstand pressure. About 30 pounds per square inch is its limit. There is nothing wrong with the aluminum as it is its nature to be rather open in structure. By experimenting it might be possible to get an alloy of No. 12 that would withstand the pressure stated. For instance the addition of 0.5 per cent magnesium would close the grain somewhat, also casting the aluminum in carbon chills would densify it. The most practical method would be to run the copper content up to 12 per cent which would close the grain of the alloy.

Removing Core Sand from Aluminum Spools

We are making aluminum spools 4¼ inches long and 2 inches in diameter. The castings are hollow and the metal thickness is ⅛-inch. Our trouble is to get the cores out of the spools without disfiguring them. We would like to find some method of dissolving and disintegrating the cores so as to wash them out of the spools.

If a water soluble binder is used in making the cores, they can be soaked and washed out of the casting without trouble. It is necessary to change the core mixture that is all. An oil sand core will not dissolve, but a flour bonded core will dissolve in water. The following is a mixture frequently used to make small cores.

MIXTURE FOR SMALL CORES

	Parts
Sharp sand	7
Molding sand	3
Flour	1

Spray the green surface of the core with molasses water.

Mixture for Superheated Steam Valve Seats

We are seeking a metal suitable for seats, disks, etc., in high pressure valves for superheated steam that will stand a temperature of 700 degrees Fahr., without deterioration or loss of strength; which will have nearly the same coefficient of expansion as cast steel and will not corrode. It should be less refractory and less expensive than monel metal.

The following mixture has been used extensively for valve seats:

VALVE SEAT ALLOY

	Pounds
Nickel	48.00
Copper	50.00
10 per cent silicon copper	2.00

A cheap metal should not be used for a valve seat. The accompanying alloy is more expensive than monel metal but it is easier to cast. It has been used and has given satisfaction. The coefficient of expansion of nickel lies very near that of cast steel and for a superheat of 700 degrees Fahr. The more nickel in the alloy the better.

Brass Castings That Will Resist Acids

We have an inquiry for brass castings that shall be acid resisting, the character of the acids being 90 per cent fatty acid derived from the combination of cocoanut oil and tallow. We would appreciate your giving us a formula for a bronze suitable for this work.

The following alloy will be suitable:

ACID RESISTING ALLOY

	Per cent
Copper	89.50
Tin	10.00
30 per cent Manganese copper	0.50

Melt the copper under charcoal. When hot and liquid add the manganese copper, stir well then add the tin. After the lapse of a few minutes, pull the pot and pour.

Casting Magnesium

We are casting an alloy composed of 80 to 90 per cent magnesium and the balance aluminum, and are desirous of eliminating the aluminum and using nothing but magnesium, but find that the only thing that will hold this metal is a steel mold. We have tried silica sand molds, skin-dried molds, green sand molds, etc. In one case the metal cuts the mold, and in the other, the silica sand, the metal will not lay. We are making castings 8 feet long, and for these it is impossible to use a steel mold because the metal chills and cracks. We will appreciate any suggestions you may be able to offer, including one giving a flux for the metal while it is being melted.

It is our understanding that when

the alloy contains aluminum it can be cast in sand molds, but when aluminum is absent it is not possible to do this. This is a case where it will be necessary to experiment until the proper molding material is discovered. The basis of all sands used for foundry purposes is silica; why not experiment with *sands* that do not have silica for a base. Possibly some reaction occurs between the silica and the magnesium. If not then it is the moisture that causes the trouble, or the air in the mold itself. This is a point to be determined and should offer no serious difficulty. If a special sand is found necessary it will probably be expensive compared to molding sand, but it can be isolated and used over and over. There are available, monozite sands, and zirconium minerals that can be bonded with china clay and made suitable for molding purposes. Also molds of silica sands can be coated with such a material as alundum cement or zirkite cement either of which would be inert at the pouring temperature of magnesium. When melting keep the crucible covered throughout the heat.

Manganese Bronze Hard to Melt in Cupola

We desire to know whether manganese bronze can be melted in a cupola? We tried this once for a large casting and made a complete failure. The metal was porous and highly oxidized. We have melted phosphor bronze in a cupola with good success.

We do not affirm positively that manganese bronze cannot be remelted in a cupola, but we would have to be shown before we would believe that it can be done and produce high grade metal. Manganese bronze can be made in a cupola; but in this case the copper and the hardener are melted together in the cupola, and are then tapped into heated ladles and the zinc is added. The mixture is made by pouring the metal from one ladle into another, back and forth several times. This is a poor way of making manganese bronze, especially for propellor castings. Good manganese bronze of uniform quality that will more than meet specifications, is not made in this haphazard way. The job of making good uniform manganese bronze is only begun after the zinc has been added. The cupola is not recommended as a melting medium for any nonferrous alloy. Even phosphor bronze melted in contact with the fuel is not as good as when melted and kept separate from the fuel. The fact that manganese bronze propellers are made from cupola melted metal on the Pacific coast does not make this method a good one for this alloy.

Trolley Wheel Mixture

We are making trolley wheels and have trouble due to sparking. We have tried several alloys as follows; (1) *Copper, 92 per cent; tin, 6 per cent; zinc, 2 per cent, with 4 ounces of phosphor copper.* (2) *Copper, 93 per cent; tin 6 per cent; phosphor copper, 2 per cent.* (3) *Copper, 95 per cent; tin, 3 per cent; phosphor copper, 2 per cent. All these alloys sparked and we widened the groove of the wheels without results. In some parts copper trolley wire is in use, and in other localities steel wire, so the wheels contact with both kinds of wire with the result that the groove sometimes gets a coating of copper and at othertimes is coated with iron. We would be pleased with any suggestions.*

It is difficult to see how any of the mixtures tried can be improved upon for trolley wheels. A copper trolley wheel would be too soft as it would batter and cease to revolve in the harp. No doubt the alternate running on copper and steel wires is the cause of much of the trouble.

As the mixtures which were tried have failed to give satisfaction a change is in order. The tin content of the following mixture can be increased or decreased as considered advisable after trials. It has been used successfully by one maker of trolley wheels.

TROLLEY WHEEL ALLOY

	Pounds
Copper	93.5
Tin	5.0
10% Silicon copper	1.5

One high speed interurban road competing with a steam road has abandoned the use of revolving trolley wheels and no sparking can be detected. The change was a very simple one in this case. The trolley wheel was cut in half, the harp battered in so the half wheel could not turn, but could oscillate back and forth making a sliding contact only. With such an arrangement a high conductivity copper slide could be used which would not arc.

Pour Aluminum as Cool as Possible

We are making castings of aluminum and have encountered trouble due to porosity after the top scale has been machined off. Various methods of molding have been tried, as well as different mixtures of metals, but in all cases porosity was found. The metal is being melted in graphite crucibles. We have used mixtures consisting of 93 per cent aluminum and 7 per cent copper, also 92 per cent aluminum and 8 per cent copper. We shall be pleased to receive any suggestions you may offer.

As a general rule these holes in aluminum are produced by pouring the metal too hot into sand molds. Experiments have shown the writer that the temperature of the metal in the furnace has little to do with the production of holes. If the metal is cooled before being poured the castings will be free of holes. Try pouring at a lower temperature. Pour as cool as the castings can be run, then get a pyrometer and determine this temperature. It can then be used as the standard pouring temperature for these particular castings. If the aluminum can be poured when it appears silvery instead of a red heat, the chances of porosity will be greatly decreased.

The porosity seems to be traceable to some reaction between the heated aluminum and the moisture of the sand, but just what occurs cannot be stated without careful study and experimentation. The phenomenon is related to the chemical activity of the aluminum, which is increased by heat, or by the addition to the alloy of more active chemical elements such as magnesium or calcium. One foundryman claims that the addition of tin up to 8 per cent remedies this defect. A large amount of study can be profitably devoted to this matter as so far we have no positive knowledge on the subject.

Copper Castings Won't Machine Well

We are having considerable difficulty in getting copper castings that will machine up clean. Our mixture is 50 per cent ingot and 50 per cent scrap copper and we melt in crucibles, in a natural draft coke-fired furnace, using a covering of charcoal over the copper. We are sending you a sample casting and will appreciate your suggestions.

From an inspection of the sample filled with gas holes, it would appear that no attempt has been made to deoxidize the copper after it was melted. This is a normal condition with copper, and sound castings are only obtained when some addition has been made to the copper with the object of removing the gas held therein.

For ordinary copper castings about 3 per cent zinc will produce a sound casting, or two per cent zinc and 0.05 per cent of 5 per cent phosphor tin. However, the castings then lose the property of electrical conductivity in a marked degree, and to retain this and make sound castings, requires very careful selection and melting of the copper. To get the castings free from holes it will be necessary to use a special deoxidizing agent.

Casting Manganese Bronze Test Bars

Several Methods of Casting Test Bars Are Tried and the Results of Physical Tests Compared—Details Are Given of the Method of Melting and the Compositions of the Alloys

BY E. H. DIX JR.

DURING the course of regular production of manganese-bronze castings for air service requirements, it became evident that a satisfactory method of casting a test bar separately as a check on melts of small castings would have to be developed. In consulting the literature on the subject and various government and technical society specifications, it was found that in general the method of separately casting a test bar is not well defined, and in several instances where a definite method was indicated, it did not seem to fit the requirements of the small experimental foundry at McCook field. It was therefore necessary to experiment with several different types with a view to obtaining a method which would first of all give uniform results; second, would be easy to cut from the coupon using a band saw such as is found in the ordinary nonferrous foundry, and which would also require as little machining as possible; third, one which would require only a small amount of metal, inasmuch as the melts poured in the foundry

METHODS OF CASTING TEST BARS ARE REPRESENTED FROM LEFT TO RIGHT BY PATTERNS NOS. TB-1, TB-2B, TB-2A AND TB-2S

rarely exceeded 130 pounds; and fourth, it was desired to obtain a method which would give results as nearly as possible comparable with the average physical properties obtained in most sand castings.

Methods of Casting Test Bars

The illustration shows the methods which have been experimented with, all casting being done in green sand. These methods will be referred to according to their pattern numbers, as indicated. A full description of these follows.

Pattern No. *TB*-1 is a common method for casting test bars of aluminum, red brass, and other metals of low shrinkage. The pouring head and riser are both 1¼ inches in diameter and a 3-inch cope is used. Usually the mold was tilted so that the pouring head would be 3 inches high and the riser about 2¼ inches high. The three specimens require 6 pounds of metal. These specimens were lettered *A*, *B* and *C*, so that the center specimen was always marked *B*. These were tested as cast, the diameter over the gage length of 2 inches being approximately ½-inch. The enlarged ends were ¾-inch in diameter and 2 inches long. The bars were pulled in wedge grips.

Pattern No. *TB-2A* illustrates a wedge riser of a type often experimented with. This mold was also made with a 3-inch cope and the riser is 3 inches across the top and tapers down to a ⅛-inch thick web, joining the test specimen. The metal was led to one end of the test bar through a long skim gate, the gate being cut entirely in the drag. A single specimen requires about 12 pounds of metal. The test specimen is ⅝-inch in diameter over the gage length and ⅞-inch diameter over the enlarged ends, thus allowing ⅛-inch on the diameter for machining to the standard ½-inch diameter by 2-inch gage length specimen. This specimen was always machined with threaded ends and pulled in self-aligning adapters.

Pattern No. *TB-2B* is similar to No. *TB-2A*, except that the web joining the riser to the test bar is ¼-inch thick instead of ⅛-inch, and requires about the same amount of metal. In general, where both Nos. *TB-2A* and *TB-2B* were cast from the same melt, they were made up in the same mold with the gating as shown in the photograph. Where either was cast alone, the gating was similar with the exception that the branch gate for the other bar was omitted.

Pattern No. *TB-2S* represents a method recommended by one large manufacturer of manganese bronze. The test bar is ⅞-inch square and is located in the drag with a cope 7 inches high. The wedge riser is 3½ inches across the top and tapers down to the full width of the bar, ⅞-inch. It requires about 33 pounds of metal. The metal is led to the test bar through a long skim gate cut in the drag. The standard ½-inch diameter by 2-inch gage length test specimen with threaded ends was machined from the square bar.

Test Bars Cut from Ingots—The American Society for Testing Materials recommends in its specifications for manganese bronze ingot casting metal that the test bar be cut from one corner of an ingot near the bottom. Some results were also obtained by this method as a check on the other methods employed.

Test Bars from Castings—In order to obtain a comparison between the separately cast test bars and test bars cut from castings, several castings have been cut up and tests made on specimens of varying sizes.

Foundry Procedure

All melting was done in an oil-burning furnace, the ordinary type of plumbago crucible being used. Charcoal was used as a covering for the melts. No other flux was used. The temperature was measured by means of a chromel-alumel couple protected by a chromon tube. The maximum furnace temperature was taken

Table I

Chemical Composition of the Alloys

Series No.	Melt No.		Copper	Zinc	Iron	Tin	Aluminum	Manganese	Total hardeners
1	540	As mixed..	56.6	40.0	1.25	0.50	1.00	0.61	3.36
		By analysis	56.82	40.0	1.14	0.59	0.99	0.47	3.18
	568	As mixed..	56.62	40.0	1.25	0.50	1.00	0.61	3.36
		By analysis	56.68	40.54	1.31	0.42	0.63	0.41	2.77
	597	As mixed..	56.77	40.00	1.25	0.35	1.00	0.61	3.21
		By analysis	56.67	40.15	1.41	0.53	0.74	0.50	3.18
	620	As mixed..	56.62	40.00	1.25	0.50	1.00	0.61	3.36
		By analysis	57.37	39.16	1.23	0.43	1.34	0.47	3.47
2	240	By analysis	58.05	38.64	1.38	0.49	1.37	0.06	3.31
	366	By analysis	56.98	39.90	1.18	0.88	0.97	0.09	3.12
3	271	By analysis	58.40	39.15	1.50	0.55	0.35	0.05	2.45
	431	By analysis	57.86	39.42	1.31	0.46	0.92	0.03	2.72
	433	By analysis	57.30	39.89	1.21	0.51	1.06	0.03	2.81
	435	By analysis	58.27	39.46	0.90	0.51	0.75	0.05	2.21

Paper presented at the convention of the American Society for Testing Materials, held at Asbury Park, N. J.

just before the pot was pulled, and again after stirring and skimming, and this temperature is denoted as the pouring temperature in Table II. It is common practice to pour manganese bronze at the temperature at which the zinc flare is noticeable only when the surface of the metal is disturbed. This corresponds to a temperature between 1700 and 1750 degrees Fahr.

The results given in this paper are only a few of the many obtained but are representative of the lot.

Series No. 1 includes metal which was made up in the McCook field foundry, using a hardener containing copper, iron, aluminum and manganese, which was also prepared in this foundry. The general procedure in mixing these melts was to charge the crucible with the required amount of copper and hardener, with a liberal covering of charcoal. When the copper was melted the zinc was preheated and added piece by piece with thorough stirring. The tin was then added and the mass allowed to soak for about five or ten minutes. The pot was then pulled, thoroughly stirred, skimmed and poured.

Series No. 2 consists of melts made up of ingot purchased from the outside. The general melting procedure was the same as in the case of Series No. 1, except that the metal was already mixed and no additions were made.

Series No. 3 consists of melts made up from another lot of ingot purchased from a different source. The melting procedure was the same as in Series No. 2.

The results given in this paper are presented in three tables.

Table I gives the chemical analyses of all of the melts, and also the proportion of elements, as mixed, for the melts made up in the McCook field foundry.

Table II gives the melting data for all of the melts.

Table III gives the results of physical tests. These are given in some detail in order that the degree of uniformity of the different methods of casting test bars may be fully shown.

A consideration of the different methods of casting test bars used in these experiments shows that the results for pattern No. *TB*-1 are always extremely low. This is particularly true of the elongation. The results are also erratic and unreliable. This agrees with the experience of many who have endeavored to use this method of casting test bars, which, although satisfactory for aluminum and red brass, is not satisfactory for a metal of high shrinkage, such as manganese bronze.

Pattern No. *TB*-2*A* also gives low and erratic results. The reason for this is perfectly evident in that the ⅛-inch

Table III
Results of Physical Tests

Melt No.	Pattern No.	Specimen No.	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation per cent	Location of fracture	Type of fracture	Brinnell, 500 kg.	Sclero-scope	Specific gravity
					Series 1					
540	TB 2B	1	45,470	83,770	22.5	M. T.	....	156	24	8.24
		2	38,900	83,370	20.5	O. T.	....	156	24	....
		3	34,360	84,480	23.5	O. T.	....	159	24	....
		Average	39,580	83,980	22.2	....	....	157	24	....
568	TB 1	3A	....	80,280	11.5	M. T.	Jagged	163	30	8.64
	TB 1	3B	40,490	64,780	5.0	M. T.	Jagged	163	30	....
	TB 1	3C	42,710	78,910	12.0	M. T.	Jagged	163	30	....
	TB 1	Average	41,600	74,657	9.5	....	....	163	30	....
	TB 2A	1A	52,920	72,730	....	O. S. G.	Jagged	119	30	8.05
	TB 2B	1B	56,200	84,310	17.0	O. T.	Jagged	119	29.5	8.15
	TB 2S	2	53,790	93,110	21.5	O. T.	Jagged	124	30.5	8.55
	Ingot	....	60,930	85,490	20.5	M. T.	Jagged	119	28	8.28
597	TB 2B	2	53,990	83,630	21.5	M. T.	Jagged	130	27.5	8.10
	a	....	43,820	72,240	13.5	....	....	99.3	23.6	8.24
620	TB 2B	....	39,720	71,910	15.5	O. S. G.	Jagged	143	27	8.27
	a	....	43,531	69,451	12.23	....	....	99.3	23.6	8.24
					Series 2					
	TB 1	1A	38,790	64,650	13	M. T.	....	48	17	....
	TB 1	1B	36,000	67,390	16	M. T.	....	80	18.4	....
	TB 1	1C	40,800	65,520	12	M. T.	....	100	21.9	....
	TB 1	Average	38,530	65,850	13.7	....	....	76	19.1	8.27
	TB 1	4A	33,420	65,750	13	O. T.	....	55	19.8	....
	TB 1	4B	41,570	65,530	15	M. T.	....	93	21.8	....
	TB 1	4C	39,770	68,680	16	M. T.	....	114	21.8	....
	TB 1	Average	38,250	66,660	14.7	....	....	87.3	21	8.34
	TB 2A	4	34,240	65,490	16.5	O. S. G.	Granular	....	....	....
366	TB 2A	6	30,610	59,790	10.5	O. S. G.	Granular	....	....	....
	TB 2A	9	34,330	67,060	17.5	O. S. G.	Granular	....	....	....
	TB 2A	Average	33,060	64,110	14.8	....	Granular	....	....	....
	TB 2B	5	32,810	67,050	22.5	M. T.	Granular	....	....	....
	TB 2B	7	30,570	70,100	26.0	O. S. G.	Granular	....	....	....
	TB 2B	8	31,690	69,510	29.5	M. T.	Granular	....	....	....
	TB 2B	Average	31,690	68,890	26.0	....	Granular	....	....	....
	TB 2S	S1	31,320	69,770	30	M. T.	Granular	....	....	....
	TB 2S	S2	32,190	69,370	30.5	M. T.	Granular	....	....	....
	TB 2S	S3	31,030	69,800	29.5	M. T.	Granular	....	....	....
	TB 2S	Average	31,510	69,650	30.0	....	....	....	....	....
240	Ingot	....	50,930	76,900	22	M. T.	Square	130	28	8.19
					Series 3					
	TB 1	1A	....	68,860	19.0	M. T.	Square	....	....	....
431	TB 1	1B	....	67,020	17.5	M. T.	Diag.	....	....	....
	TB 1	1C	....	48,770	9.5	Flaw	....	....	....	....
	TB 1	Average	....	67,940	18.3	....	....	....	....	....
	TB 1	1A	....	65,090	15	M. T.	Jagged	....	....	....
433	TB 1	1B	....	69,410	20.5	M. T.	Jagged	....	....	....
	TB 1	1C	....	62,330	12	M. T.	Jagged	....	....	....
	TB 1	Average	....	65,610	15.8	....	....	....	....	....
	TB 1	1A	....	41,680	6.5	M. T.	Jagged	....	....	....
	TB 1	1B	....	65,670	15.0	M. T.	Jagged	....	....	....
	TB 1	1C	....	68,310	19.5	M. T.	Jagged	....	....	....
435	TB 1	Average	....	58,550	13.7	....	....	....	....	....
	TB 1[3]	2A	....	43,900	12.0	M. T.	Cupped	....	....	....
	TB 1[3]	2B	....	43,090	12.5	M. T.	Cupped	....	....	....
	TB 1[3]	2C	....	75,840	22.0	M. T.	Jagged	....	....	....
	TB 1[3]	Average	....	56,280	15.5	....	....	....	....	....
431	TB 2A	2A	....	66,490	23.5	M. T.	Diag.	....	....	....
433	TB 2A	2A	....	70,540	32.0	M. T.	Jagged	....	....	....
435	TB 2A	3A	....	71,050	36.5	M. T.	Diag.	....	....	....
	TB 2A	Average	....	69,360	30.7	....	....	....	....	....
431	TB 2B	2B	....	70,210	30.0	M. T.	Jagged	96	23.5	8.28
433	TB 2B	2B	....	71,150	37.5	M. T.	Jagged	100	24	8.30
435	TB 2B	3B	....	70,260	36.5	M. T.	Diag.	105	22.5	8.33
	TB 2B	Average	....	70,540	34.7	....	....	100	23.3	8.30
431	TB 2S	3	....	70,380	30.5	M. T.	Jagged	....	....	....
433	TB 2S	3	....	69,290	33.5	M. T.	Jagged	....	....	....
435	TB 2S	4	....	71,230	39.0	M. T.	Jagged	....	....	....
	TB 2S	Average	....	70,300	34.5	....	....	....	....	....
271	Ingot	....	44,820	71,820	33.5	M. T.	Jagged	109	24.5	8.21

a Average of 15 small test bars cut from casting shown in Fig. 2, Pattern No. X19342, weight, 53 pounds.
[1] M. T. = Middle Third; O. T. = Outside Third; O. S. G. = Outside Gage.
[2] Not included in the average.
[3] Skin turned off reducing diameter about 0.02 inch.

Table II
Melting Data of the Heats

Series	Melt No.	Weight, pound	Percentage of scrap	Time in furnace hours	Maximum temperature, deg. Fahr.	Pouring temperature, deg. Fahr.
1	540	48	none	2⅛	*b*	....
	568	124	none	2	1800	1750
	597	127	none	2¼	1800	1760
2	620	129	none	2	1820	1720
	366	300	*a*	1½	1750	1700
3	431	100	none	1½	1750	1700
	433	100	50	1½	1750	1700
	435	100	50	1½	1750	1700

a This melt made up in three meltings of 100 pounds each, the first being all new metal and the other 50 per cent scrap from previous melts.
b Protecting tube burnt through but temperature judged by zinc flare to be 1700 to 1750 degrees Fahr. when pulled from furnace and it was poured immediately.

web is not sufficiently heavy and freezes, thus preventing proper feeding action from the riser.

Pattern No. *TB-2B* has been found in all of the tests made to give uniform and reliable values. As an evidence of the uniformity, the three bars from melt No. 540 furnish a fair example.

Pattern No. *TB-2S* also gives uniform results, but ones which are believed to be fictitiously high, as, for example, 93,000 pounds per square inch obtained in melt No. 568.

The test specimens prepared from ingots in accordance with the specifications give results which are more nearly in accordance with those obtained from pattern No. *TB-2B* than any other method.

The test specimens cut from the two castings shown in Fig. 2 give an average result somewhat lower than the figures obtained from pattern No. *TB-2B*. It is, of course, well known that the physical properties vary throughout different parts of the same casting, so that no one test bar can represent the physical properties in a casting. However, in choosing a method of casting test bars, it is desirable that the results obtained should be somewhat comparable to the average physical properties of the general run of castings.

Pattern No. *TB-2S* gives results which are so much higher than the average obtained in the castings that the designer would be seriously misled if this method were adopted.

It is interesting to compare the metal in the three series on the basis of the two methods of casting *TB-2B* and *TB-2S*. Considering first the results from pattern No. *TB-2S*, melt No. 568 shows 93,000 pounds per square inch, with an elongation of 21 per cent, whereas, the other two series would each show about 70,000 pounds per square inch, with 30 to 35 per cent elongation. Thus, melt No. 568 would be judged far superior to the other two.

Considering the results from pattern No. *TB-2B*, melt No. 568 shows 84,000 pounds per square inch, with 17 per cent elongation, whereas series No. 2 shows 69,000 pounds per square inch, with 26 per cent elongation, and series No. 3 shows 70,000 pounds per square inch, with 35 per cent elongation. In other words, on this basis the metal in series No. 3 is shown to be of equal quality with melt No. 568, the only difference being that one is harder than the other, and series No. 2 is shown to be rather inferior. It would thus seem that, while some metals show good properties when fed in the exaggerated method of pattern No. *TB-2S*, yet when put in commercial castings where this amount of feeding is impossible, the results would not be as satisfactory.

Pattern No. *TB-2S* is an exaggerated case of methods being employed at present. A more reasonable method employed by one company is to cast a block about 4 inches square and of the desired test bar length, to the bottom of which are attached two or more square coupons for test specimens. The objection to this is that it is very difficult to make a straight cut 6 or 7 inches long through metal ⅞ or 1 inch thick on the ordinary band saw, especially in a hard metal like manganese bronze. The riser in the case of pattern No. *TB-2B* is so proportioned that, although the web is only ¼-inch thick at the point of joining to the specimen, the riser begins to taper immediately, leaving just enough room for a saw cut, and the riser is further made sufficiently heavy so that it holds enough heat to prevent the web from freezing until the test bar is sufficiently well fed up to give uniform and dependable results. The test specimen may then be cut from the riser in the foundry and the fin ground off, so that in the machine shop it is only necessary to turn off ⅛-inch of metal.

First Few Taps of Iron Come Down Cold

Question:—Formerly we lighted our 36 inch furnace with wood and the first iron was hot enough to pour the thinnest casting in the shop. We have recently installed an oil burning equipment and we have to pig the first 400 or 500 pounds unless we happen to have castings that are not of much consequence. We pour about 6 tons a day, castings ranging from one to 6000 pounds. The torch is applied to the breast hole for about 25 minutes or until the fire shows red at the tuyeres. Two hours later the wind is put on and the bottom dropped in about 1¼ hours. Charges are made up in the proportion of 40 pig iron and 60 scrap.

Answer:—Without a personal investigation it would be rather difficult to say why your first iron comes down dull. Oil burners are used extensively for lighting cupolas and so far as we are aware are giving satisfaction.

However, we can tell you what probably is the cause of your trouble. Your bottom sand may be too wet or you may be introducing the burner flame through the tap hole after the breast has been made up. Judging from your indicated melting speed, 12,000 pounds in 1¼ hours for a 36 inch cupola, your melting practice is all right. This is also borne out by the statement that when you started the fire with wood the first iron was hot.

The sand forming the bottom should be drier than sand used for molding. When wood is used a good hot fire is assured all over the bottom before the coke becomes ignited; consequently the bottom sand is perfectly dry and hot before the first iron comes down. With the oil burner this is different. The flame enters the small tap hole, shoots up on the inside and the coke immediately on the botom, except for a short distance in front of the tap holes, does not light. When the first iron comes down it falls on a cold bed and naturally cools.

After a few hundred pounds have melted the coke on the bottom is brought to a red heat, the bottom sand is also heated and from that point on the iron is hot enough.

To overcome your difficulty, introduce the burner before making up the breast. This will allow a sufficient volume of air to enter with the flame to ignite the coke all the way across the bottom. The breast can be made up after the bed has burned through. The fact that two hours elapse between the time you light the furnace and put on the wind also seems to indicate that your fire is choked for want of air. With the breast and tuyeres wide open you should be able to put the wind on an hour after starting the fire.

It would be well also to check up on your fan. A 36-inch cupola should melt about 5 tons of iron an hour, and since it requires about 30,000 cubic feet of air to melt one ton of iron your fan will have to deliver approximately 150,000 cubic feet of air an hour or 2500 feet a minute.

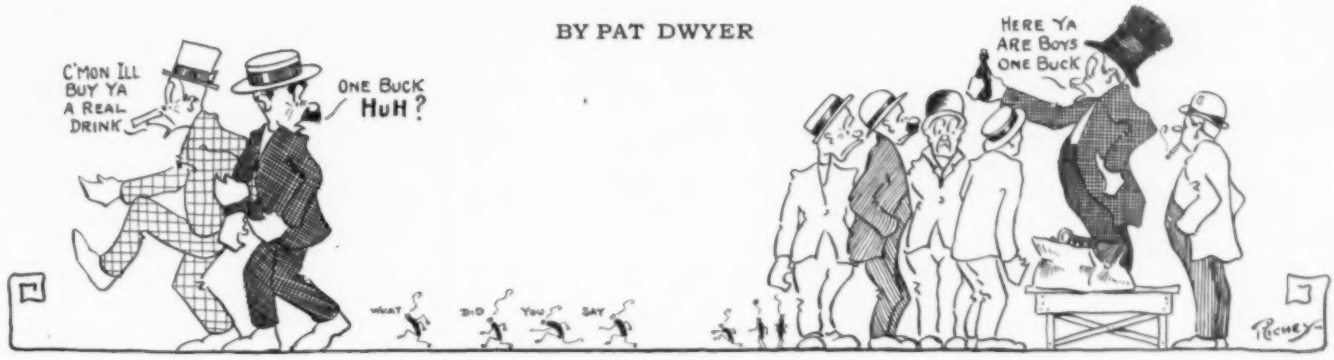
Plan Live Programs

The Pittsburgh chapter of the American Society for Steel Treating has planned an extensive and interesting program for the coming season. The October meeting will be featured by an address by President Carpenter of the E. F. Houghton Co. on "Individualism vs. Socialism." In November Professor Sauveur, Harvard University, Cambridge, Mass., will speak on heat treating steel. Prof. H. F. Moore, University of Illinois, Urbana, Ill., will discuss fatigue testing and resistance of materials at the December meeting.

Robert B. Ferguson is now the sales representative of The Buckeye Products Co. in northern Ohio and Michigan. Prior to his connection with The Buckeye Products Co. Mr. Ferguson covered this territory as representative of the Hill & Griffith Co. He formerly acted as sales representattive for The Buckeye Products Co. for a period of about 10 years.

Bill Reviews Some Gear Maker's Problems-IV

BY PAT DWYER



PASSING a down-town corner the other day, the same being Labor Day, a legal holiday and therefore a day on which we are forbidden to engage in any form of gainful occupation, Bill and I were attracted by the sight of a crowd of men apparently paying the closest attention to the remarks of a gentleman mounted on a small table or platform in the center of the crowd. Drawing closer we trickled in to satisfy our curiosity and presently gathered from his remarks pitched in that peculiar tone one usually associates with Plymouth Rock, Bunker Hill, The Spirit of '76, and The Old Homestead, that the orator had been captured by wild Indians while yet a child and had grown up as a member of the tribe. He had found favor in the eyes of the chief medicine man who had imparted to him all his secrets including the proper method of compounding remedies from the roots, barks, herbs, gums, berries and balsams scattered so prodigally over the face of the earth by the great mother, Nature.

So well had the old medicine man done his work, that upon his death the speaker had been elected to fill the vacancy. He might have held the position indefinitely, but one day while looking through some of the old man's possessions he came across a small photograph of a lady with a child. He recognized his dear mother (tremolo stop) and himself, then a baby. Immediately he had been seized with an uncontrollable impulse to seek his own people in the home of his childhood and despite the most intense grief and frantic efforts on the part of his adopted people to hold him, he had set out a few months previously to satisfy the dictates of his heart. (Business of holding one hand over his cigar pocket). Innocent and unsophisticated, brought up with the children of nature in the wild fastnesses of the Rocky mountains he had received a rude awakening upon his entry into civilization. He discovered that without money a man could neither eat nor travel, and as he never had had an opportunity of learning the white man's ways of doing work, he was confronted with the startling and painful alternative of begging or starving. Thank heaven, gentlemen he never yet had been forced to sit on the former horn of the dilemma and if those good people in front of him had as much sense as he was sure they had and if they took advantage of the opportunity which presently he intended to set before them, why, then, he confidently expected also to avoid the second.

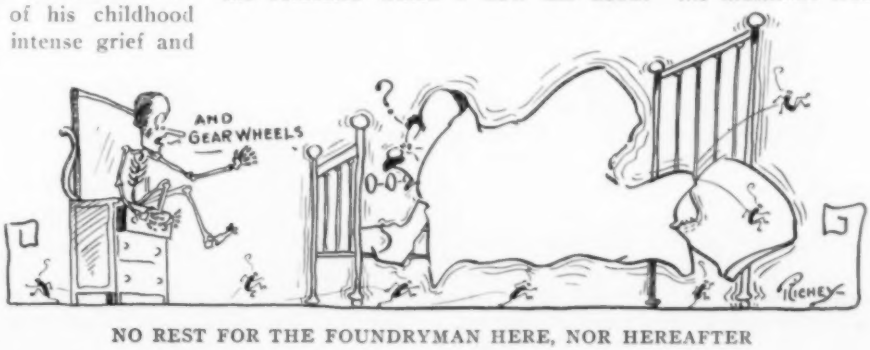
Entirely by accident he had been called upon to exercise his knowledge of nature's remedies in one of the frontier posts of the Far West and the gratitude of the people had been expressed in such an appreciative and tangible manner that it had suggested to him a method of paying his expenses and at the same time conferring a boon on suffering humanity.

"Understand me clearly, gentlemen," said he. "This is not a money making proposition. I neither have the desire nor the inclination to capitalize the misery, the tears and the suffering of disease ridden humanity. My early life was spent among those who have no conception of the importance of the almighty dollar. The ingredients of the remedies which I now am about to offer for sale are gathered in the fields and the forests as I travel along and I merely charge a nominal price, just sufficient to enable me to meet my modest expenses on the way to the home of my forefathers".

He then entered into a long harangue on the many diseases arising from an impure blood supply, culminating in the display of a bottle containing a dark brown liquid guaranteed to cure anything from specks before the eyes to ingrowing toe nails. He was prepared to offer a limited number of these bottles containing the Elixer of Youth for the insignificant sum of one dollar a bottle or six for five.

From a perusal of vital statistics and claims frequently made in the newspapers published in this city I had been under the impression that possibly with one or two exceptions this was the healthiest city in the United States; but from the manner in which that crowd surged forward and snatched the bottles of precious elixer, I am forced to the conclusion that whoever compiled the vital statistics must have been in error. After allowing the usual 75 per cent discount for the tone adopted by the newspapers in boosting the old home town I still am afraid that they exaggerated when discussing hygienic conditions. Taking that crowd as a typical cross section of the population I should be inclined to say offhand that this should be a great town in which to hold an undertaker's convention.

After he had supplied the wants of the multitude from an apparently inexhaustible grip in a manner that suggested the story of the loaves and fishes he held up one hand and implored attention while he said a few concluding words. Far to the west is a desert land with its mountains of snow, the Spanish



NO REST FOR THE FOUNDRYMAN HERE, NOR HEREAFTER

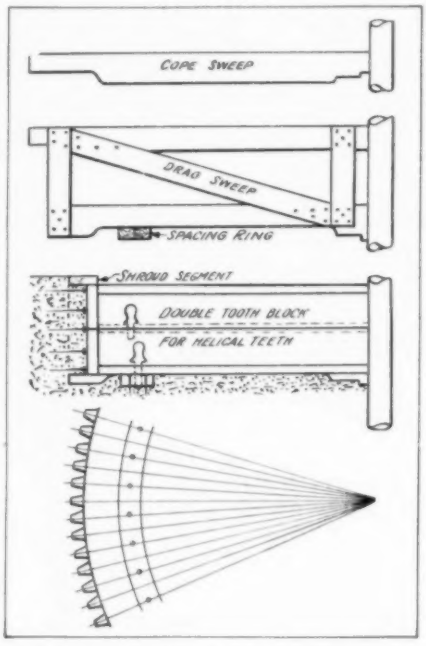
Sierras. The warriors of the tribe which had adopted him, lived and hunted in this land from youth to old age. Sickness practically was unknown and except through accident the warriors had to wait until extreme old age unlocked the portals of the happy hunting grounds. They lived a healthy outdoor life, ate as occasion offered, slept in the open wherever night found them and slaked their thirst at the pure sparkling rills, heaven's own beverage prepared by the hand of God himself to nourish and invigorate mankind.

However, it was different with the squaws. They lived and slept to a certain extent under cover and therefore they suffered in a measure from those peculiar ailments which afflict those who live in civilized communities; coughs, colds, hoarseness, asthma, bronchitis, whooping cough and all diseases of the respiratory organs, the chest, throat and lungs. He was happy to say that his old preceptor had compounded an infallible remedy and if taken in time, a preventative for any of the ills enumerated. It was not prepared in bulk, it could not be purchased at a drug store and once he had left the town it would be impossible to secure it at any price. He had a limited quantity with him which he now would pass out to the audience at fifty cents for the small bottle, three for one dollar; or one dollar for the large bottle, six for five dollars.

He had no need of impressing the necessity of a suitable remedy on those suffering from any form of disease of the respiratory organs. They realized their condition and no urging was necessary on his part; but he did wish to exhort those who thought they were well to make a careful self analysis. Tuberculosis, the great white plague which claimed its victims by the millions every year frequently was heralded only by a slight cough. One bottle of the remedy, taken at this time, might be the means of saving your life, or maybe the life of some one near and dear to you. Just think of it, weight a dollar against a human life.

"Come on," said Bill. "Let us get out of here. I never have been sick since I was a kid and I never have taken a dose of medicine since I was held by the nose and made to swallow castor oil; but if I listen to that bird any longer I will feel convinced that I have a touch of everything from the pip to housemaids knee and that if I live until Christmas it is all I reasonably can expect."

"Some time before you decide to shuffle off the mortal coil," I said, "it might be a relief to get the last chapter of that gear wheel business off your mind. I know you never would rest easy in the grave if you had something to say and had been nipped off before you had a chance to say it. It is not that I am so anxious to hear the story, but I don't want to have your ghost come tracking soot and



NUMBER OF HOLES IN THE SPACING RING WILL DEPEND ON THE NUMBER OF TEETH ON THE SEGMENT

ashes into my bedroom some night in the future and have to lose a good night's sleep while you sit on the bed post and talk about gear wheels."

"Departing for the moment," said Bill, "from the abstract and coming right down to a concrete instance I shall tell you about the method adopted for making a set of gear wheels which for all practical purposes was as accurate as a gear molding machine and one which I afterward adapted to making small plain spur wheels. The set of gears to which I refer ranged in diameter from 5 to 10 feet, double shrouded, cycloidal, helical teeth and only one casting to make off each pattern.

"As a rule, a whole pattern for a large gear is out of the question on account of the cost and in this particular instance on account of the peculiar shape of the teeth the cost of the pattern actually was prohibitive. A second factor largely responsible for the method finally adopted was that the train gears had to be ready for installation in the mill at a given time which precluded the possibility of making whole patterns. The boss patternmaker, a product of "Glesca" and the most clever lad in his line I ever had the pleasure of working with, devoted some earnest thought to the subject and solved the problem in a manner that resulted in a train of perfect gear wheels and at a cost for pattern making that was truly insignificant. The total pattern outfit comprised two half-gear blocks with three teeth on each block, one spacing ring, one cope and one drag sweep, one corebox for the arm cores and another corebox for the center core.

"After the plan of procedure had been decided upon, a cope sweep was made and sent to the foundry. A hole was dug to a suitable depth in the foundry floor, a coke bed and vent pipes were set and after a spindle seat and spindle had been adjusted and plumbed in the center, the hole was filled with sand and rammed flush with the floor level. The cope sweep then was attached to the spindle and used to sweep a bed on the floor corresponding to the top face of the wheel and extending far enough beyond the circumference to act as a bearing for the cope. The cope was set on this bed, rammed, staked, lifted off and finished and then set up on stands to be skin dried, which however, was not done until the night before the wheel was cast.

"In the meantime, the pattern makers had been busy on the remainder of the rigging and by the time the molder had the hole dug again, this time to a size that would give about 1 foot clearance all around to provide room for ramming and rodding the teeth properly, the segments containing the teeth, the spacing ring and the drag sweep were ready and sent to the foundry. The spacing, or locating ring is the distinctive feature of this process and like nearly all mechanical appliances which have given the greatest satisfaction it is extremely simple. Those who have employed the usual segments with one, two or more teeth for making gears, know how extremely slow and annoying is the process of setting the segments so that the last tooth will coincide with the first after the segment has been tried all around the circle. I never have seen it come apparently right on the first trial only once and then a recount showed the molder that he only had 67 teeth where he should have had 68.

"By the use of the spacing ring, this guess work is eliminated, for if the holes in the ring should vary a fraction of an inch the corresponding teeth will only be affected slightly and the error will not be accentuated as the making of the wheel progresses, an annoying feature that always develops when the ordinary gear segment is employed.

"The diameter of the ring makes little difference. Any convenient size will answer the purpose. For a 7-foot

CHEMICAL ANALYSIS OF PLAIN CARBON STEEL

DETERMINATION OF SILICON BY THE NITRO-SULPHURIC METHOD

(*Continued from data sheet No. 396*)

Solutions Required

Nitro-Sulphuric Acid—Mix 1000 cc. of sulphuric acid, sp. gr. 1.84, 1500 cc. of nitric acid, sp. gr. 1.42, and 5500 cc. of distilled water.

Dilute Hydrochloric Acid—Mix 100 cc. of hydrochloric acid, sp. gr. 1.20, and 900 cc. of distilled water.

Method

Add cautiously 80 cc. of the nitro-sulphuric acid to 4.702 g. of steel, in a platinum or porcelain dish of 300 cc. capacity, cover with a watch glass, heat until the steel is dissolved and evaporate slowly until copious fumes of sulphuric acid are evolved. Cool, add 125 cc. of distilled water, heat with frequent stirring until all salts are dissolved, add 5 cc. of hydrochloric acid, sp. gr. 1.20, heat for 2 minutes, and filter on a 9-cm. paper. Wash the precipitate several times with hot water, then with hot hydrochloric acid and hot water alternately complete the removal of iron salts, and finally with hot water until free from acid. Transfer the filter to a platinum crucible, burn off the paper carefully with the crucible covered, finally igniting over a blast lamp or in a muffle furnace at 1000 degrees Centigrade for at least 20 minutes; cool in a desiccator and weigh. Add sufficient sulphuric acid, sp. gr. 1.84, to moisten the silica and then a small amount of hydrofluoric acid. Evaporate to dryness, ignite and weigh. The difference in weights in milligrams divided by 100 equals the percentage of silicon.

Notes

A blank determination on all reagents used should be made and the results corrected accordingly.

SULPHURIC-ACID METHOD

Solutions Required

Dilute Hydrocloric Acid—Mix 100 cc. of hydrocloric acid, sp. gr. 1.20, and 900 cc. of distilled water

Method

To 2.351 g. of steel, in a beaker of low form of 500 cc. capacity, add 60 cc. of distilled water, and then cautiously 15 cc. of sulphuric acid, sp. gr. 1.84. Cover with a watch glass, heat until the steel is dissolved and evaporate until copious fumes of sulphuric acid are evolved. Cool, add 100 cc. of distilled water and heat with frequent stirring until the salts are in solution. Filter on a 9-cm. paper, wash the precipitate several times with cold water, then with cold dilute hydrochloric acid until free from iron, and finally with cold water until free from acid. Ignite and weigh. Add sufficient sulphuric acid, sp. gr. 1.84, to moisten the silica and then a small amount of hydrofluoric acid. Evaporate to dryness, ignite and weigh. The difference in weights in milligrams divided by 50 equals the percentage of silicon.

Note

A blank determination on all reagents used should be made and the results corrected accordingly.

(*Continued on data sheet No. 398*)

CHEMICAL ANALYSIS OF PLAIN CARBON STEEL

DETERMINATION OF COPPER

(*Continued from data sheet No. 397*)

Solution Required

Sulphuric Acid—Mix 200 cc. of sulphuric acid, sp. gr. 1.84, and 800 cc. of distilled water.

Potassium Ferrocyanide—Dissolve 10 g. of potassium ferrocyanide in 100 cc. of distilled water.

Standard Copper Nitrate—Dissolve 2 g. of purest electrolytic copper in 20 cc. of nitric acid (1:1), and dilute to 1000 cc. with distilled water. Each cubic centimeter is equivalent to 0.02 per cent of copper on the basis of a 10 g. sample.

Method

In a 300-cc. beaker dissolve 10 g. of the steel in 75 cc. of the sulphuric acid, and then add 150 cc. of distilled water. Heat the solution and saturate with hydrogen sulphide, filter and wash the precipitate free from iron with 1 per cent sulphuric acid containing hydrogen sulphide. Incinerate the paper with its contents in a porcelain crucible and fuse with 0.5 g. of acid sodium sulfate. Extract with hot water, filter, and complete the determination colorimetrically as under 1 (a) or 1 (b), or electrolytically as under 2 as follows:

1. Evaporate the filtrate to about 25 cc., make faintly ammoniacal, filter into a 100-cc. Nessler tube and wash with hot water.

(a) If the solution is a strong blue, to another 100-cc. Nessler tube add 50 cc. of distilled water, 5 cc. of ammonium hydroxide, sp. gr. 0.90, and from a burette the standard-copper-nitrate solution until the blue colors match.

(b) If the solution is a faint blue, to the filtrate in a Nessler tube add the dilute sulphuric acid to faint acidity and then a few drops of the potassium- ferrocyanide solution. To another 100-cc. Nessler tube add 50-cc. of distilled water, a few drops of the potassium-ferrocyanide solution, and from a burette the standard-copper-nitrate solution until the reddish brown colors match.

2. Make the filtrate slightly acid with sulphuric acid, dilute with distilled water to a suitable volume, and determine the copper electrolytically.

(*Continued on data sheet No. 399*)

THE FOUNDRY DATA SHEET, SEPTEMBER 15, 1921

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

wheel, the ring was made in the usual manner by gluing segments together and was turned in the lathe to finish 5 feet 10 inches outside diameter and 5 feet inside diameter. It was made 2 inches thick. A line was scribed on the face of this ring using a radius of 31¼ inches. A similar line was scribed on the layout of the wheel and radial lines drawn from the center of each tooth. The points where these lines intersected were then transferred to the corresponding line on the spacing ring and by the aid of a wooden jig 1-inch holes were bored at every second mark. Short wooden plugs provided with a handle at one end and a shoulder about half way, were used in these holes later for locating the pattern block on the spacing ring.

"The tooth block for this particular wheel was provided with three teeth designed to form two sand teeth each time it was moved and for that reason it only was necessary to bore a hole in the spacing ring on every second radial line leading from the centers of the tooth. Had the block been provided with two teeth and therefore only capable of forming one sand tooth at a time it would have been necessary to bore a guiding hole at each radial line intersection. From this it is apparent that the number of holes in the spacing ring is dependent on the number of teeth on the block.

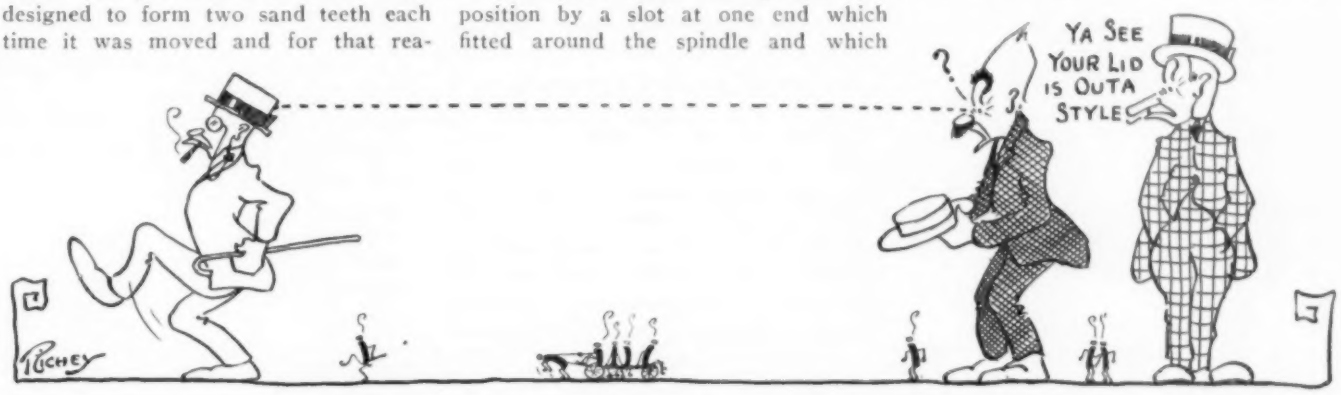
"Circumstances will determine the most convenient number of teeth to fasten on the block. The helical teeth were drawn in toward the center and therefore two teeth were the most that could be made at one time; on some of the wheels it was possible to make only one tooth at a time. Where the teeth are drawn vertically, as in ordinary practice, the tooth block may contain any number from 3 to 12 teeth. Any molder who has attempted to set a gear pattern back in the mold after it once has been drawn knows that the teeth are bound to *shave* the sand going down. Therefore, when laying out the tooth segment to be used in conjunction with the spacing ring, it is advisable to select a multiple of the total number of teeth that will bring the last segment out even or at most with an overlap of one or two teeth.

"After the hole had been dug to the required depth, the spacing ring was laid on the bottom. It was supported on four bricks spaced approximately an equal distance apart. The drag sweep was then adjusted on the spindle and slowly swung around affording an opportunity to locate the ring at the proper height by a wedge on top of each brick. A suitable mark on the lower edge of the sweep served to locate the ring in its proper position in regard to the spindle. After the bed had been swept and the sweep removed, the ring was anchored firmly by a number of 6-inch spikes pushed through holes provided for that purpose.

"The tooth block was guided into position by a slot at one end which fitted around the spindle and which permitted the pattern to be drawn away from the sand teeth in a horizontal direction. The plugs previously referred to were employed to hold the rim part of the block in position while the sand was being rammed in the teeth. After each pair of teeth was rammed the plugs were removed, the block withdrawn, swung around to the next position and located properly by dropping the plugs in the next set of holes in the spacing ring."

"I have seen an adaptation of that idea in only two foundries situated in widely separated parts of the country," I said, "and I often have wondered why it has not been adopted to a greater extent by foundries in general."

"That is one of the seven wonders of the world," said Bill. "Let some cuckoo in New York decide this year to wear his hat one inch narrower in the brim that it was last year and before three months have elapsed every free and independent voter from the Great Lakes to the Rio Grande will be wearing a little hat with a narrow brim; but let some foundryman get up a rig or a machine to improve operating conditions in his foundry and if it is adopted by two other foundrymen in the course of a year it will constitute a record."



YOU PROBABLY HAVE NOTED THAT WHAT'S ON A MAN'S HEAD ATTRACTS MORE ATTENTION THAN WHAT'S IN IT

Annealing Aluminum

Aluminum castings such as oil pans of motor cars are somewhat difficult to weld when broken, owing to the liability of the part drawing out of shape while cooling, or cracking owing to the locked-up stresses, according to *Autogenous Welding*, published by the Davis Bournonville Co., Jersey City, N. J. If the part changes shape much it will be impossible to reassemble it, and if held rigidly to a steel frame while cooling so as to maintain the original form there is danger of cracking.

One of the most effective materials for insulating preheated aluminum castings and preventing cracks while cooling is dry soft-wood sawdust. The sawdust should be used liberally, covering the welded casting to a depth of, say, two inches. If dry it is an excellent insulator, and if the casting is quite hot it is likely to take fire and smolder slowly, thus extending the cooling period considerably. An aluminum casting so treated will be annealed so soft when cooled that it can be bent without fracture.

In this connection it is of interest to note a method employed by coppersmiths to anneal large copper and brass sheets and keep them flat. The same method is used for aluminum and monel sheets. After being heated the sheets are laid between dry pine boards and left to cool. The boards are excellent heat insulators and as the wood chars and smolders for a time the slow combustion helps to maintain the heat. The sheets cool very slowly and when finally cool will be found soft and easily bent.

The Barkay Co., Inc., Jamestown, N. Y., recently purchased the interests of F. W. Fairbanks in the Fairbanks Art Bronze Works of that city and incorporated for the manufacture of nonferrous castings.

Routing Systems in the Pattern Shop

A Plan Responsible for the Increased Production in Closely Related Departments May Be Adapted To Fit the Peculiar Conditions Obtaining in the Patternmaking Department

BY B. RUPERT HALL

ENTHUSIASM in the apprentice entering any of the several crafts requiring special skill, often is of short duration this generally is due to the acts of thoughtless persons who never consider the possibilities that may be attained by continual striving toward the betterment of the craft. Enthusiasm more than any other one thing surely and fully will develop these possibilities; consequently it should not be discouraged.

The evident progress made in the production of castings should be an incentive to the one engaged in patternmaking to plan and develop new ideas; to rearrange and in some cases discard old ones; to speed up and keep pace with the great change in the processes of molding resulting from the increased use of molding machines. I would encourage the apprentice in patternmaking to visualize the possibilities of the craft and become a master of the art, thus preparing himself for responsible positions in the future.

Patternmaking an Art

The term pattern is applied to a device, usually made of wood or metal, having the general form of the finished casting with possibly the addition of core prints. Similarly, the craft is called pattern making and the artisan a patternmaker.

To be efficient, the craftsman must be familiar with the molding process in its various branches, bench and floor molding, machine molding, sweep work, skeleton work, and coremaking. He must be skilled in his own trade which requires accurate, clean-cut work and nicety of finish. Few patterns have more than a general similarity. Special features involving careful and constantly varying methods of construction make the work of the patternmaker extremely interesting.

The first authentic record of the modern conception of the art of founding, is credited to England between 1345 and 1355. In that early time a piece of work was designed and often carried through to completion by a single individual, who took up in turn each of the processes of designing, patternmaking, molding, casting and machining. In the natural course of industry, specialization was developed more and more as its advantages became recognized. About 1840, a general division of artisans was effected in which the patternmaker took his place as a clearly defined artisan, requiring a skill and knowledge unlike any of the others. This specialization still is taking place until there hardly remains any requirements formerly demanded of some of the crafts.

Speeding Production

In patternmaking there is great room for the introduction of methods into the work for speeding-up production, but apparently specialization in a single operation has not been worked out to the completion of the pattern. A series of processes, distinct in themselves, closely unite the departments of designing, drafting, patternmaking, founding, and machining. The common means of communication between men engaged to these trades is orthographic projection. The category of patternmaking assets includes ability to produce a mechanical drawing, a working knowledge of geometry, a good sense of proportion, and understanding of the strength and properties of materials, a general acquaintance with machine tools, an appreciation of the point of view of the foundryman and the machinist, quick, accurate judgment and resourcefulness, and a keen visionary conception of the product.

A pattern may be made of any material, such as wood, wax, plaster of paris, metal or other substance which lends itself readily to change of form. The material to be used is determined largely by the nature of the objects to be formed and by the number of castings required. Where many castings are to be made, metal patterns usually are employed. The pattern first constructed, from which the metal pattern is made, is called a master pattern, and since metal shrinks on cooling, both patterns must be made oversize to allow for the shrinkage. Consequently, the master pattern must be made doubly oversize, or as a pattern maker would say, made to double shrink. Frequently it is desired to make a metal master pattern, usually when the metal is thin, form is intricate, and a wooden master may become damaged. The metal master is made from a wood master in which allowance is made for triple shrink, the first in the cooling of the metal master, the second in the cooling of the metal working pattern, and the third in the cooling of the casting itself. Skeleton patterns, sweeps and pattern sections, may be used to advantage especially in the making of large castings or simple ones, such as flat plates, blocks, plain cylinder, etc. In the mold for a flat plate, an open frame called a skeleton pattern may be used to make the mold, and the sand enclosed by the frame swept out by a sweep sliding along the frame. This saves much material in such cases of simple forms. The same principle can be applied to large patterns of various shapes where the size of the whole pattern and mold lends itself to touching up after the mold is made. The skeleton pattern is recommended in cases where one or two castings are required.

Pattern Material

The patternmaker generally is regarded as a worker in wood. The wood most commonly used for patterns is white pine which is serviceable and easily worked. Because he does work in wood, an efficient patternmaker must be familiar with the care and use of hand machine tools, must be expert in wood carving, and must be well informed concerning the nature of the pattern material and the metal of the casting as well.

To convert the engineer's flat drawing into a form resembling the final product the patternmaker must have imagination, and creative ability, besides an understanding of mechanical drawing. It is the usual practice to use scale drawings to facilitate handling and filing, but sometimes a full size drawing is used to clarify the appearance of the joining parts. In other instances a sectional view of some intricate part gives greater clearness. Simple patterns often may be constructed directly from the blueprint.

It is not usual, especially in small shops, for the patternmaker to be called upon to design a casting suitable for certain machine parts. In such cases he becomes a designer, and must know the principles of machine design, involving practical application of geometry, trigonometry, strength of materials, and ability to give an artistic and graceful appearance to the form of the part. The principles of molding and coremaking

should be thoroughly understood. Internal stresses due to shrinkage and contraction give the patternmaker interesting problems, the solutions of which are obtained only by the application of the science derived from the combinations of theory and practice. Where such strains are apt to occur, they are avoided by the introduction of cores or cooling devices. At times it becomes necessary to distort the pattern so that the casting in cooling will warp into the proper shape.

Co-operation Necessary

Molding machines and special equipment for standardized work should be considered as carefully as the machines used in the construction of patterns so that the foundry limitations will not be disregarded or overestimated. Thus confusion and delay in the expected output may be avoided. Owing to the close connection between the pattern shop and the foundry, the highest possible degree of co-operation should exist. Those who endorse the combining and control under one head of these two departments are taking a big step toward elimination of departmental friction.

Largely due to the character of the work done in the pattern shop, methods of handling the products have not undergone as great changes as they have in other closely related departments. Pattern work being a means to an end is not considered direct production work, yet it is an absolute necessity. A peculiar condition of the pattern making trade is that the men engaged in the craft generally are skillful and considered capable in working out the problems that confront the individual workman. While the present plan may be considered satisfactory by many, it does not prevent others who are anxious to promote progress from giving some thought to workable methods that, if perfected and adopted, would place pattern production on a level with that secured in other closely related departments. Efficient production depends upon getting the best from the workmen, and this obviously is impossible unless the engineer is thoroughly familiar with the work, tools, and labor saving devices of the workmen, all in their proper relation to each other. Knowledge of the work also stimulates the respect and confidence of employes, which is not to be disregarded. The foundry and pattern departments are so closely allied that the pattern man, to be effective in his work also must be familiar with the foundry, machine shop and drafting departments.

The products of the pattern department are not produced in quantity, hence the general plan of the department organization, Fig. 1, necessarily must differ in some respects from that of other departments engaged in quantity production. The main problem of the pattern department is to be able to arrive at conclusions quickly, to avoid unnecessary waste of time and material and to perform the work in hand in an expeditious manner. To do this an efficient system must be adopted. Care in pattern building and due consideration of the molding problem call for keen skill and visualization that only can originate from serious and careful thought. The establishing of the pattern parting must be carefully considered for here the efficiency of production in the foundry will either be hastened or retarded. The theory that a pattern must be tried out in the foundry before receiving the final *OK* is a thing of the past. The efficient patternmaker can give a guarantee for satisfactorily producing a mold before it ever leaves his layout table, and when it has passed through the inspection of a careful checker a double-check is assured on its merits. While all this carefulness would tend to call for quality in place of quantity, workable methods of production could be adopted to assist greatly in the production of patterns. In adopting an outline of organization, it would appear that the ar-

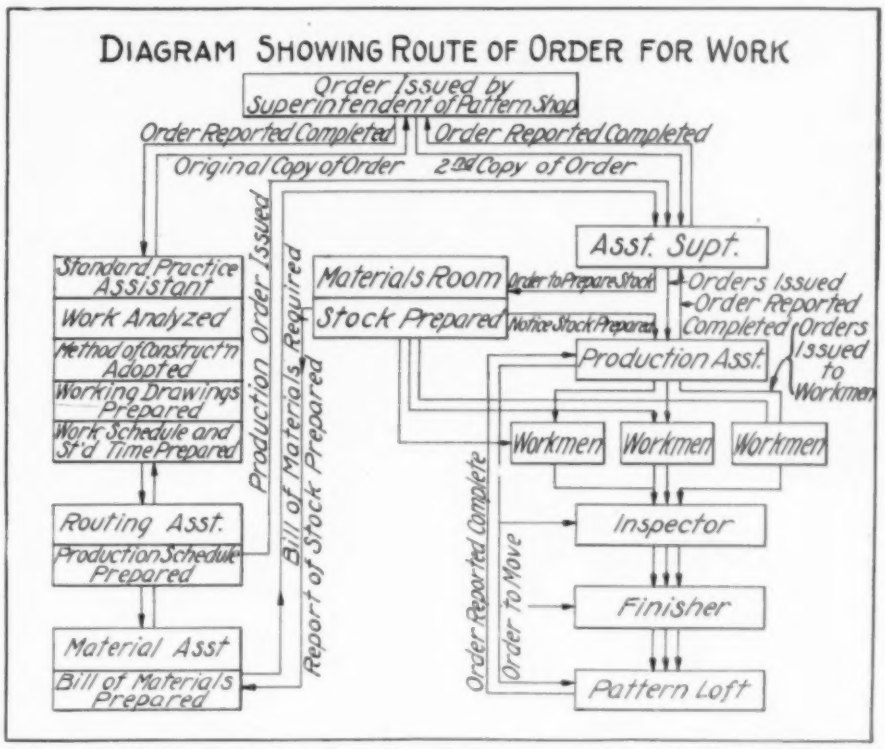


FIG. 2—SUCCESSIVE STAGES IN THE ROUTE OF AN ORDER FROM THE TIME IT LEAVES THE SUPERINTENDENT'S OFFICE UNTIL HE IS NOTIFIED THAT THE PATTERN IS COMPLETED

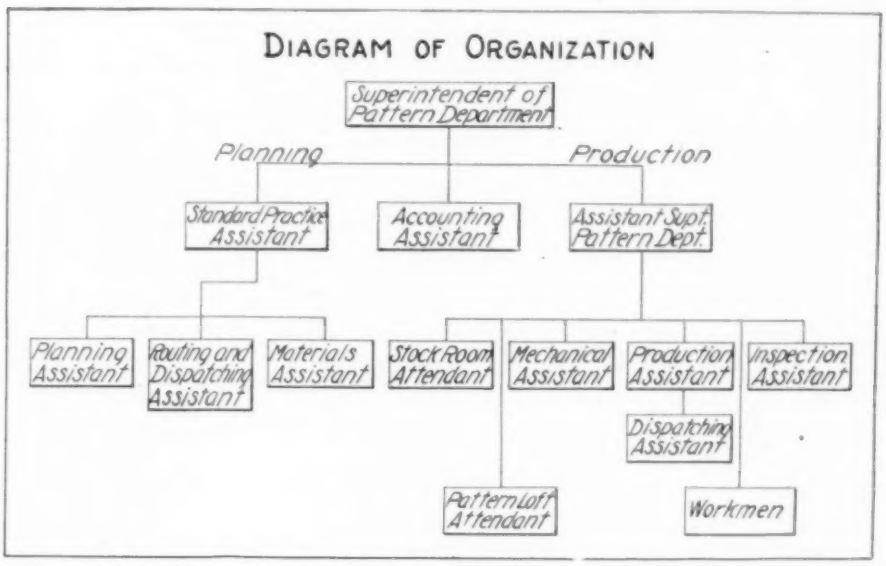


FIG. 1—IN SMALL SHOPS ONE MAN COMBINES THE DUTIES OF SEVERAL OFFICES

rangement would depend on the number of patternmakers employed; but anyone familiar with the work of either a large or small shop can see that the plan could be used equally well in a small or large department. In a small shop one man would act in three or more offices if it became necessary.

Two Divisions in Organization

The successful functioning of any department or plant must be controlled by an organization consisting of all individuals directly responsible for the working of the department authorized to carry out plans designed for the department. Organization then establishes the determining factors of responsibility. The diagram given in Fig. 1 indicates the organization applicable to a pattern department, definitely showing the requirements of each responsible head. The organization is made up of two divisions, planning and production, both being under the direct supervision of the superintendent of the department. Planning, under the direct supervision of the standard practice assistant, is subject to orders directly from the superintendent and the standard practice assistant also is an assistant to the assistant superintendent, these two heads working harmoniously together for the betterment of production of product. The assistant superintendent attends to the development of plans recommended by the superintendent and to such other detail as are required in the upkeep of a well equipped shop. Naturally enough, following the organization shown in Fig. 1, a system or combining of department heads is introduced causing all suboffices to function smoothly like a train of accurately cut gears.

By a study of the diagram of organization, Fig. 1, it will be observed that planning and production are the principal divisions considered. Under planning, the work is divided as follows:

The standard practice assistant is thoroughly conversant with methods of construction commonly employed in the pattern department, determines the quality of work required and issues orders accordingly. The planning assistant carries out the directions of the standard practice assistant, makes necessary working drawings, establishes a standard time on all operations, and gives required estimates of work. The dispatching or routing assistant directs the course of procedure through the department after the work has been carefully planned. The materials assistant directs all work of getting out stock and having it ready in accordance with the schedule of the dispatching or routing assistant.

Production is controlled by the standard practice assistant and his staff, co-operating with the assistant superintendent. The production assistant acts as assistant to assistant superintendent, the other heads functioning as indicated by diagram.

The best manner in which to describe the functions of each part of the organization is to trace an order, issued by the superintendent, from his office through the department and back to his office again, as indicated in Fig. 2. The superintendent receives a factory order for a pattern which is to be made in the shop as soon as possible.

Two copies of an order reach the shop, one of which goes to the planning department and the other to the production department. The production department is not permitted to go ahead on the pattern until they receive a production order from the planning department. The first action taken on an order after it leaves the office of the superintendent is by the planning department and the description if the process of filling an order, necessarily starts there.

The planning department is made up of three subdivisions: standard practice, dispatching or routing, and stock or materials. The standard practice assistant takes the order and the drawing which accompanies it and makes an analysis of the job. He studies it from several different angles, decides on the method of construction advisable, and prepares a work schedule, telling how much time should be spent in preparing the pattern. The advantage of having a special department to plan out this part of the work is that it makes for a uniformity of pattern construction and saves time in the planning of a job usually done by the patternmaker. From the standard practice assistant the order goes to the dispatching or routing assistant.

Makes a Production Schedule

The dispatching or routing assistant helps the assistant superintendent by taking the order and information prepared by the standard practice assistant and laying his plans for the production of the pattern. He determines the number of men required for the job, makes out a production schedule, and issues a production order for the assistant superintendent. From there the order goes to the material assistant who has charge of the stock.

The materials assistant studies the order from his point of view, determines the materials which will be required to fill it and prepares a statement of material for the assistant superintendent. The order now has progressed from the superintendent, through the planning department to the assistant superintendent who has complete charge of its production.

The assistant superintendent at this time has in his hands three papers relative to the order which started from the office of the superintendent, a copy of the order from the superintendent, a production order from the dispatching or routing assistant, and the bill of materials from the materials assistant. Upon receipt of the latter, he issues two orders, one to the production assistant for the manufacture of the pattern, and the second to the stock room for preparation of the material. Upon completion of the preparation of stock, the production assistant is notified and the stock is retained until the assistant superintendent issues the order to the workmen who proceed according to instructions. Upon completion of the pattern, the job is inspected by the inspector, by order of the assistant superintendent or production assistant; after which it is finished and sent to the pattern loft. Upon receipt of the pattern, the production assistant is notified by those in charge of the pattern loft. The production assistant notifies the assistant superintendent who in turn notifies the superintendent of the completion of the piece of work.

Portland Cement Is Not a Suitable Facing

Question: In going through a foundry recently I noticed that after the molds were finished and ready to close the molders sprinkled Portland cement over the surface. I had never seen this done before and upon inquiry was told that the cement was used because the sand was poor. The castings were rough when shaken out. I would appreciate any information you can give me on this subject.

Answer: The use of Portland cement as a facing for molds simply is a fad on the part of the foundryman in the plant where you saw it employed. It is used in a few places, but never with any benefit. On the contrary its continued use will render the sand unfit for service. Its use probably was suggested in the first place by the fact that cement hardens when exposed to the action of water. The hypothesis on the part of the foundryman was that a thin film of cement spread over the damp surface of the mold would absorb moisture and form a hard skin on the face of the mold.

A close, fine sand will scab under the action of the molten iron, but the remedy for this condition is not to be found altogether by imparting a hard skin to the surface of the mold. Skin drying a mold will produce a satisfactory casting even with an inferior grade of sand, but the result is attained through a combination of natural circumstances. The skin drying prevents

the surface from scabbing, but the casting *peels* clean because the surface of the mold is covered with a refractory substance in the shape of graphite or plumbago.

The ideal molding sand is one with a relatively high silica content and a correspondingly low clay and lime content. Portland cement is prepared from a rock composed of clay and lime, neither of which is sufficiently refractory to withstand the heat of molten iron. The rock is quarried, crushed and then heated to approximately 2000 degrees Fahr., after which it is ground to an impalpable powder. It is particulary well fitted for a cement inasmuch as it fills the interstices between the sand grains and binds them firmly together, but for the same reason it distinctly is *not* fitted for use with molding sand where the object is to maintain the openings between the grains to carry off the steam and gas generated during the pouring process.

Where the sand is subject to scabbing the obvious remedy is to substitute a more open grade instead of trying to doctor inferior material because it happens to be on hand.

Quantity Production of Intricate Parts

BY HERBERT R. SIMONDS

THE manufacture of many of the intricate parts used in textile machinery calls for many castings of a unique nature. Probably few branches of industry have put so many problems up to the molder as has that of the manufacture of textile machinery. A typical example of a malleable textile casting is shown in the accompanying photographs. Fig. 2 shows the patterns in place in the match and in the foreground shows the completed gate of castings, with the cores and core box. An idea of the size of the pieces themselves may be obtained from Fig. 1.

FIG. 1—PLACING THE CORES REQUIRES CARE AND PATIENCE AS THE WALLS ARE THIN AND ACCURACY IS ESSENTIAL

Each flask contains 24 castings which are mounted on two separate gates of 12 castings each. The total weight of castings alone for one flask is 1.47 pounds or .062 of a pound per casting. Because of the thinness of walls at the cored end of the castings, considerable difficulty has been encountered in developing a successful method of gating and pouring. Unusually heavy risers are used as shown in the illustration. Each piece is double gated and the metal is poured at an unusually high temperature. The sprue weight for one flask is 2.38 pounds or 0.099 pound per piece, which is nearly 50 per cent more than the weight of the casting.

In the textile trade, this particular piece is known as a loop, and is used on the underneath motion of a loom. A good molder will complete the mold of 24 parts in ten minutes. The cores themselves are relatively small and it requires approximately four minutes to make the 24 used in one flask.

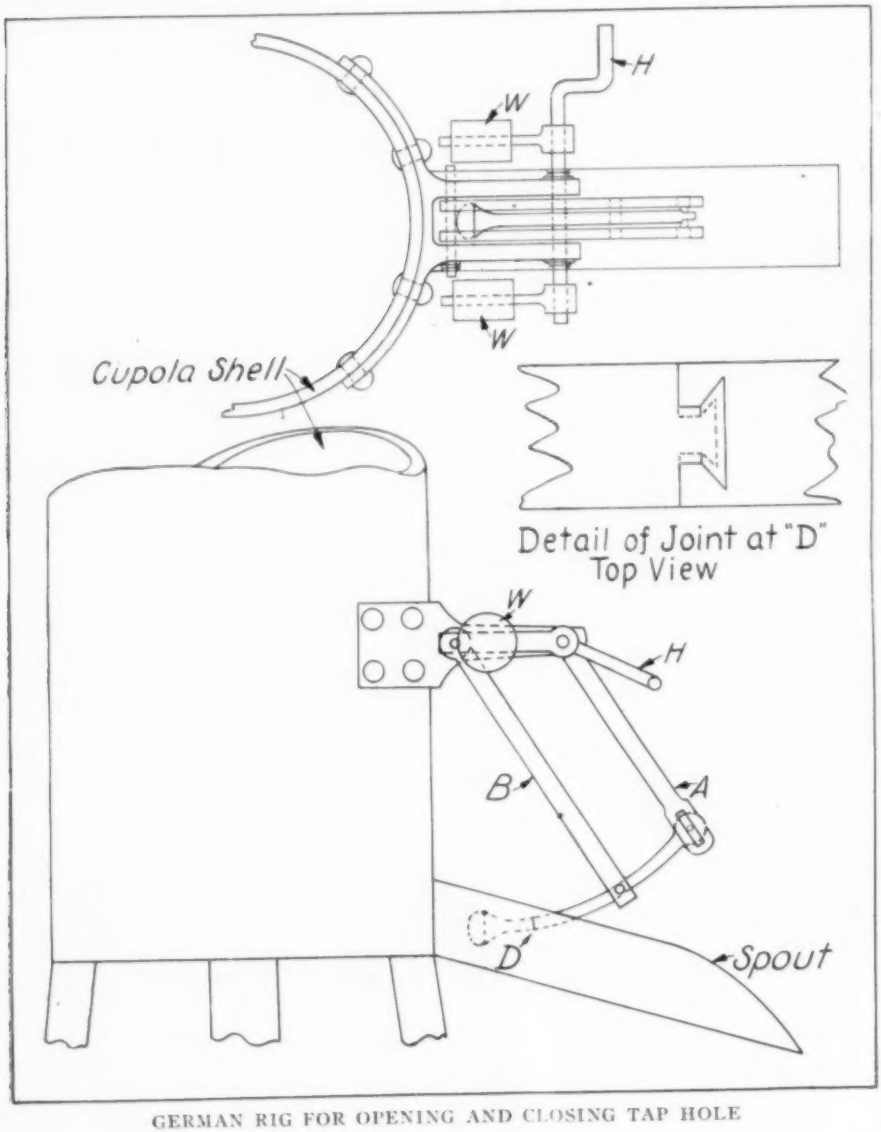
Even at best, with careful gating, and design of pattern, this particular job is an unusually difficult one. It requires a skilled man to handle it and even then the percentage of loss is high. Under normal operation the loss is approximately 33 1-3 per cent. From the metal gates the two halves of the mold are made by the use of the match as shown in Fig. 2. The gate or pattern is drawn from the mold by use of a draw stick and hand rapping while the plate is vibrated.

FIG. 2—THE COMPLETED CASTINGS AS TAKEN FROM THE MOLD ARE SHOWN IN THE FOREGROUND AND AT THE BACK THE MATCH WITH GATES IN PLACE

Cupola Tapping Device

A mechanical bott-stick for opening and closing the tap hole is fitted to each of the cupolas in the new gray iron, agricultural implement foundry of Fried Krupp A. G., at Essen, Germany. Its construction is shown in the accompanying illustration. A saddle bracket riveted to the cupola shell about 3 feet above the spout carries two pairs of links, *A* and *B*, which have their upper ends pivoted on short shafts. The shaft connected to link *A* is extended and fitted with counter-weights, *W*, and a crank handle, *H*. The lower ends of the links carry the bott-stick, which is curved as shown in the illustration. The bott-stick is pivoted on the lower ends of the links *B*, but a sliding connection is provided with the links *A*, and both pairs of links are so proportioned kinematically, that the lower end of the bott-stick, carrying the clay ball or spear, as the case may be, moves horizontally.

The bott-stick is provided with removable end-pieces which are connected to the main part of the stick by means of tapered dovetails as shown at *D*, and in the enlarged sketch of this connection. Some of these end pieces are sharpened to form a spear or punch for breaking out the tap-hole at the beginning of a cast. Others have flat ends to which the clay-balls are stuck. Several of the latter with the clay balls ready prepared are kept on hand for instantly cutting off the flow of metal if emergencies should arise.



GERMAN RIG FOR OPENING AND CLOSING TAP HOLE

This device is positive in action and there is no difficulty in stopping the most active cast, or in boring out a refractory tap-hole. One man operates the device usually with one hand on the crank handle. The counter-weights are sufficiently heavy to pull the links out of the way when the device is not in use. The danger of being burned from splashes of molten metal is eliminated, and this is stated to be one of the greatest advantages of the device, coupled with the fact that the flow of metal is under absolute control, and that the over-filling of ladles is obviated.

Make Pattern Shop Power Tools Convenient

By M. E. Duggan

Under ordinary circumstances when a pattern is commenced by one or more workmen it is carried through to completion without any interruption. Each workman does his allotted part if working on a large pattern and does all the work if making a small pattern. He does his own marking, boring, turning, planing, sawing, etc., and since it is necessary that the progress of the work be along a definite line it sometimes happens that two or more men desire to use one of the power machines at the same time. For this and other reasons a considerable amount of work is done by hand in many patternshops which should be done on power driven machinery.

A pattern shop with a single lathe, a planer, a band saw and a rip saw is the rule rather than the exception; while the shop with a lathe as the sole piece of mechanical equipment is by no means uncommon. In the majority of cases the lathes are of simple if not crude construction without either slide rest or automatic feed motion.

Owing to some features peculiar to pattern making, such as the extreme accuracy and finish desired on some of the parts, hand work can be employed to advantage. Furthermore, it is possible in many cases to do a job by hand in about the same time it would require to set a machine for the purpose. Sharpening the knife in a hand plane can not be compared with a similar job involving the removal and replacement of a set of cutters in a power driven tool. However, if a machine can be set *easily and readily*, if it does not occupy too much floor space, if it is not too heavy and if it is designed to perform several operations it can be utilized to advantage in any pattern shop.

An incident illustrating one of those features came to my attention recently when I saw a patternmaker step up to the foreman and heard him requesting permission to take out the ½-inch band saw and replace it with a narrower ¼-inch blade. He had some small circles to cut and the ½-inch blade was too wide.

I asked the foreman what was the idea in requiring the men to secure permission before attempting to change a saw blade. He said that the outfit, meaning the saw and saw guard, was not convenient. Changing a saw was a nuisance and caused considerable delay. A ½-inch saw was kept in use all of the time because in his opinion it was best suited to general requirements. He

claimed that a smaller saw would not last any length of time.

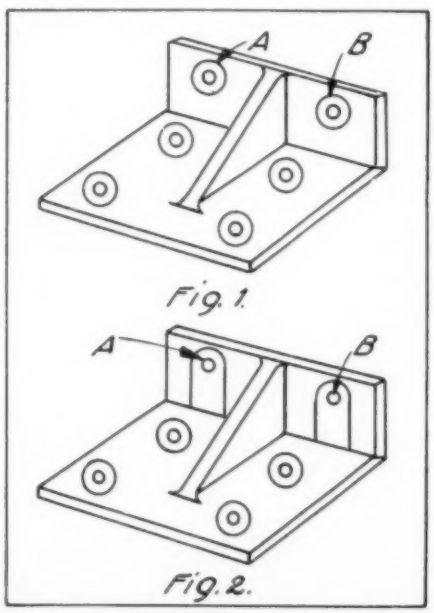
The guard on my band saw can be opened in 10 seconds. Saws can be changed in a few minutes and I never use anything wider than a ¼-inch saw whether cutting thin or thick stock. Where the ½-inch saw is used for general sawing, it cannot be utilized to advantage when cutting small circles and consequently stock is left on which must be removed later with chisel and gouge. This is one of the reasons why I approve of having at least two band saw machines in a pattern shop where a considerable number of patternmakers are employed.

Brazing band saw blades is a process practiced indifferently in many pattern shops. It is a process requiring special equipment as well as nice skill and judgment and in my experience I have never seen it done satisfactorily; that is, I have never seen a break repaired so that the saw was as good as new. The proper place to have band saws brazed is where they specialize in that kind of work.

Pattern Design Affects Operating Costs

By Richard Bates

On many orders a substantial reduction of costs may be secured if the foundryman is consulted on the design and construction of the pattern. For example, consider the usual program in a large plant engaged in the production of special and jobbing castings. The engineers in charge will make up new designs and hand them over to the draftsmen to work out the details. After the drawings are finished they are taken to the shop where patterns are constructed with a view to securing the largest possible production with a minimum risk of loss and in the case of orders calling for large quantities of duplicate castings, with a view to reducing the foundry work on each unit to a minimum.



IT IS MUCH SIMPLER TO MOLD THE PATTERN SHOWN IN FIG. 2 THAN THAT IN FIG. 1

In many cases castings are so designed with ribs, lugs and brackets that cores, loose pieces and special equipment are required to make them conform to the drawings. This is extra work that could be avoided if the foundryman and designer could get together before the drawings are sent to the shop. Draftsmen, as a rule, are not familiar with foundry practice and therefore do not make their drawings with foundry conditions in mind. Again, some engineers will not consent to any change after the drawings are finished. The shops have to accept them and worry along the best way they can. The engineer must design for strength and appearance and in many cases it would appear that these are the only factors that receive consideration. The result is that the foundry goes on producing castings in lots of 100 when with a few minor changes in design it might be producing lots of 300 in the same time and at a corresponding reduction in cost.

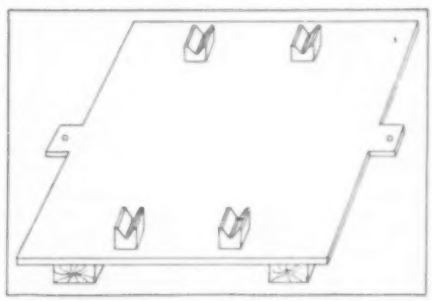
The bolt holes in the bracket shown in Fig. 1 are surrounded by raised bosses. To make this casting it is necessary either to make the bosses *A* and *B* loose and draw them into the flange after the pattern has been drawn out of the sand; or to make and apply dry sand cores to form the bosses on the face of the casting. Either method will retard production and increase the cost. If the pattern is made as shown in Fig. 2 with the bosses extended to the base the castings can be made in larger quantities, at a corresponding reduction of cost and compare favorably in appearance with that shown in Fig. 1. Draftsmen do not seem to realize the importance of these small details.

Locates Bars in the Cope

By Michael R. Burns

The bars in a cope rammed on a jolt machine must be attached firmly to the sides to prevent them from moving during the ramming operation. In many cases, copes are barred in a special manner to fit certain jobs and when that job is not in the shop the flasks cannot be used for any other. If they are used it means that a considerable amount of time has been spent in removing the bars and replacing them with others. The device shown in the accompanying illustration may be adapted to facilitate the work in many instances. I first adopted it when confronted with a new jolt machine, lots of work; but no flasks barred. A set of 30 x 30-inch flasks, barred for a special job was pressed into service by cutting a number of wooden bars and wedging them in place.

Four white metal blocks were attached to a dummy board as shown in the illustration and four similar blocks were attached in corresponding positions on the pattern plate. One man placed each cope in turn on the dummy board, dropped two bars in until they came to rest in grooves in the blocks, then he drove a wooden wedge at the top of one end, broke it off flush and after the bars were clay washed the cope was ready for the machine. When in place on the table of the machine the lower edges of the bars fitted into the grooved blocks and were held firmly while the machine was jolting.



THE METAL BLOCKS MAY BE ATTACHED TO THE BOARD AT ANY CONVENIENT POINTS

It readily can be seen that this idea can be adapted to fit various sized copes under varying conditions. The dummy board is only required if a large number of flasks are to be handled.

The Society of Industrial Engineers will hold its fifth annual convention in Springfield, Mass., Oct. 5, 6 and 7. Industrial stability will form the main topic of discussion, and under this head, the four major functions of industry: Production, finance and accounting, sales and industrial relations will be considered.

The Pioneer Brass Works, Indianapolis, has removed from 418 S. Pennsylvania street to 1102 E. 23rd street in that city.

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Business Acumen Is Needed

WITHOUT good business judgment a foundry company cannot be made a success regardless of how much molding and metallurgical experience may be marshalled in the management and the supervisory force. Making the casting is only one of the problems confronting the foundryman. He must also know how much it costs to melt the iron, make the mold and finish the casting, including the amount absorbed by depreciation and other overhead expense. Then he must know when to buy his supplies and how much to charge for his castings. This latter would be comparatively simple if it were only necessary to calculate the cost of materials and the manufacturing cost to which to add a fixed overhead and a fair profit. Unfortunately this is not all that is required. The overhead fluctuates with the rate at which the shop is operated and if figured to give a fair profit, the cost of the castings would be excessive when the shop is operating only 25 to 35 per cent of capacity. Some managers average their overhead for the year and in normal times this is a satisfactory policy. However, in the present state of business many foundries are cutting under their average overhead to get business. Here is where wrong judgment may mean a considerable loss to the company. As an example take a company which would lose $2000 a month if it were closed and no work was taken. This company might set a price which would bring it 40 per cent operation and only lose $1000. Then the question would come up the next month as to whether a cut in price would increase the business enough to break even or at least cut down the loss. Possibly there would not be enough business in the market to increase the production of the foundry and in this case a cut in price would be detrimental instead of beneficial.

To decide this point both local and general fundamental conditions must be studied. As the greater portion of jobbing foundry business is done with the local trade a careful estimate must be made of the local business conditions, both as to the volume of demand and the effect of a price cut on competitive foundries. If all foundries in a certain field would go after business with the determination to get it at any cost, the results would be fatal to some of the companies. A false conclusion in the judgment of one foundryman may cause trouble for all. In the general business field, the foundry manager should know the facts governing general business and should be able to weigh them when making a decision on business policy. If he can forecast the course of business he can take advantage of low prices or avoid paying an excessive price. At present the fundamental conditions are so hazy that few venture to provide for more than their immediate needs. However, a few are buying supplies for future needs and furnacemen are less anxious to sell. In practically all districts the price of pig iron has stopped its long decline and in several sections an advance in price has been made. Usually when an advance in price is started it means a revival in business. A slight stimulation has undoubtedly taken place in the iron and steel business and some authorities see in this the beginning of a revival.

Trade Outlook in the Foundry Industry

DESPITE the improvement which has been noted in many industrial lines, the castings business remains practically on the same low level. Except for a few special lines, foundry operations are at the same point as was noted early in August, when the bottom was reached in many other lines. The stimulus which has been injected into general trade conditions has failed to react upon the castings plants, and although betterment is noted in the production of pig iron, and a better tone and firmer prices are noted in many industries, the foundries are but little benefited. However, many optimistically expect a steady pick up through the late fall, and satisfactory business by the first of the year.

Signs Grow Better

Perhaps the most hopeful evidence that the low point in the curve of business depression has been passed is furnished by the pig iron production statistics. According to figures gathered and tabulated by *The Iron Trade Review*, August showed the first gain for a period of 10 months. During the past month, a total of 948,850 tons of coke and anthracite pig iron were produced, registering a gain of 84,208 tons over the July total of 864,642 tons. This was with the same net total of stacks in operation and for the same number of days operation. The daily average production was 30,608 tons as compared with 27,892 tons for July, a gain of 2716 tons per day or 9.7 per cent. The production of merchant iron during August fell to 138,440 tons which represents a loss of 2886 tons as compared with the July total of 141,326 tons. On an average daily basis, the August total was 4466 tons, a loss of 93 tons when compared with the July average of 4559 tons per day. One additional stack making merchant iron was blown in during the month.

Prices of Raw Material for Foundry Use

CORRECTED TO SEPT. 8

Iron		Scrap	
No. 2 Foundry, Valley	$21.00	Heavy melting steel, Valley	$13.00 to 13.50
No. 2 Southern, Birmingham	19.00 to 20.50	Heavy melting steel, Pitts	13.00 to 13.50
No. 2 Foundry, Chicago	21.00 to 22.00	Heavy melting steel, Chicago	11.00 to 11.50
No. 2 Foundry, Philadelphia	20.35 to 21.75	Stove plate, Chicago	13.50 to 14.00
No. 2 Foundry, Buffalo	19.50 to 21.00	No. 1 cast, Chicago	14.50 to 15.00
Basic, Valley	19.00 to 20.00	No. 1 cast, Philadelphia	16.50 to 17.50
Basic, Buffalo	19.00 to 20.00	No. 1 cast, Birmingham	15.00 to 16.00
Malleable, Chicago	21.00	No. 1 cast, Buffalo	12.00 to 12.50
Malleable, Buffalo	20.00 to 21.00	Car wheels, iron, Pittsburgh	15.00 to 15.50
Coke		Car wheels, iron, Chicago	14.50 to 15.00
Connellsville foundry coke	$3.75 to 4.50	Railroad malleable, Chicago	14.50 to 15.00
Wise county foundry coke	6.00 to 6.75	Agricultural mal., Chicago	14.50 to 15.00
		Railroad malleable, Buffalo	11.50 to 12.50

Stocks Are Low

Although the apparent consumption of foundry iron was lower in August than in previous months of the depression, a slight increase in the melt was reported. Pig iron salesmen who are thoroughly conversant with the situation report that the stocks of pig iron in storage in foundry yards is at the lowest point. Further, foundrymen have refrained from buying beyond their immediate needs on the falling market. Indications of slight stiffening in pig iron prices have been followed in all localities by awakening interest with an endeavor to contract iron for the last quarter and in some cases for the first quarter of 1922. That the turning point has been reached and passed is evident, even though no marked improvement in castings orders is reported. Malleable foundries throughout the country still continue to produce at about 25 per cent of their capacity. The demand for railroad malleables, except for repair purposes is negligible. Agricultural implement manufacturers, too, are not buying, and the demand for farm machinery remains unstimulated.

New England Quickens

In the New England district, the low point in foundry operations was passed about Aug. 1. At present the production of castings ranges above 20 per cent, except in machine tool lines where little betterment is noted. A number of metal working plants which have been closed have resumed. From all sections, stove foundries report a slight improvement in demand. Jobbing foundries, in general, are experiencing little betterment in orders. Cast-iron pipe makers in the South and in the East alike have a quantity of orders on hand and in sight which probably will enable them to operate comfortably for the next six months, when normal seasonal reductions probably will come into effect. Soil pipe and fittings producers, also are booking orders, but are not operating above 50 per cent. On the western coast, foundry operations, as indicated by pig iron sales are slightly better and some effort is being made to buy iron in advance of immediate requirements. Patternshops in the New England district and in the central states report an increase in demand. The automobile industry in general is slowing down, although makers of a few popular passenger cars still are operating at from 50 to 80 per cent of capacity. Truck and tractor demand still is quiet, with but little prospect for improvement during the remainder of the year. Railroad equipment orders still are exceedingly light with but little prospect of an increased demand this fall. According to figures issued by the Railway Car Manufacturers' association, 3892 cars for domestic and 433 cars for foreign use were delivered during July. This compares with 2245 domestic and 413 foreign cars made and delivered during June.

Nonferrous Slow

No improvement is evident in the demand for nonferrous castings. Prices of nonferrous metals based on New York quotations in the *Daily Metal Trade* of Sept. 8 follow: Casting copper, 11.75c; electrolytic copper, 11.87½c to 12c; lead, 4.50c; antimony, 4.40c to 4.50c; Straits tin, 26.75c; aluminum, No. 12 alloy, producers' price 23.80c to 24.00c and open market, 16.00c to 17.00c. Zinc is 4.20c to 4.25c, E. St. Louis, Ill.

Personal

Robert B. Moir has been appointed New York manager for the W. A. Jones Foundry & Machine Co., Chicago, with offices at the warehouse of the company, 20 Murray street.

H. E. Mandel now is general manager of the Pennsylvania Foundry Supply Co., Philadelphia. He recently resigned his connection with the Lindsay Chaplet & Mfg. Co.

Professor MacIntosh, Carnegie Institute of Technology, Pittsburgh, addressed the local chapter of the American Society for Steel Treating Sept. 6 on "The Metallurgy of Iron and Steel."

John Christianson, formerly assistant superintendent of the Phoenix Mfg. Co., Eau Claire, Wis., has been appointed superintendent of the gray iron foundry of Kewanee Boiler Co., Kewanee, Ill.

Charles H. Kittenering, president of the Defiance Machine works, Defiance, O., has been named special representative to act for the Chinese government in the United States in connection with the purchase of machinery for various developments in China.

Robert E. Kennedy, superintendent of the foundry of the University of Illinois, has been engaged as assistant secretary of the American Foundrymen's association. He will be chairman of the papers committee of the association and until that work actively begins has been assigned to sand research work. For the present he will continue to make Urbana, Ill., his headquarters.

W. L. Chandler, Doge Sales & Engineering Co., Mishawaka, Ind., was unanimously chosen for re-election as president of the National Association of Purchasing Agents by the nominating committee of that body. Among the other officers nominated were A. H. Reinhardt, Poole Bros., Chicago, first vice president; W. J. Gamble, Vulcan Steam Forging Co., Buffalo, treasurer; and L. F. Boffey, 19 Park place, New York, secretary.

D. D. Lewis has been appointed general manager of the Carroll Foundry & Machine Tool Co., Bucyrus, O. Mr. Lewis began his career in Johnstown, Pa., where he grew up in the business and devoted much time to blast furnace and rolling mill construction. He was identified with the Cambria Steel Co., the Jones & Laughlin Steel Co., and the Algoma Steel Co., the latter of Sault Ste. Marie, Ont., and other concerns. W. E. Matthew, who has served as secretary and general manager of the Carroll company will continue as secretary as well as a member of the executive committee.

H. S. Huncke has been appointed western sales manager for the Lumen Bearing Co., Buffalo, with offices at 15 N. Jefferson street, Chicago. Henry Waters has been made associate salesman in the Chicago office. The territory embraced by the sales work of this branch will include Michigan, with the exception of Detroit, and the territory west of a line through Toledo and Columbus, to Cincinnati, as well as the states of Kentucky, Tennessee and Georgia.

English Cost Men Study American Methods

The English Institute of Cost and Works Accountants has sent representatives to attend the second international cost conference held in Cleveland on Sept. 14, 15 and 16 under the auspices of the National Association of Cost Accountants. Dr. McLeod, secretary of the National association states that the English representatives are planning to spend some weeks in this country, studying American cost methods and, upon their return, will make a detailed report to the English Institute based upon their observations here.

Malleable Cost Experts to Meet in Chicago

The September meeting of accountants of the American Malleable Castings association comprised a two day session held at Hotel La Salle, Chicago, on Sept. 12 and 13.

One meeting was devoted to papers and reports on machine methods of accounting. These covered the character of the information recorded by the use of the Hollerith tabulating machine, the Stromberg recorders and other makes of machines in use by certain members. The reports showed in addition to the nature of the information recorded, the results secured and the savings effected. Another session was devoted to a presentation of the subject of graph charts designed to show how information can be pictured for the ready grasp of the executive who finds it difficult to read figures and to gain their significance.

Robert E. Belt, secretary-treasurer, of the association presided, and H. J. Ward, National Malleable Castings Co., Cleveland, was secretary.

Bayard Phillips Is Dead

Bayard Phillips, aged 42, treasurer of Phillips & McLaren, foundry and machine works and secretary of the Pittsburgh Foundrymen's association died recently at his home in Pittsburgh. He was born in Glenfield, Pa., June 30, 1879. He attended Park institute, was graduated from Washington & Jefferson college in 1898 and from the Western University of Pennsylvania school of medicine in 1901. He spent one year as an interne at St. Francis hospital and four years as resident physician for the Pressed Steel Car Co. Since 1906 Mr. Phillips had been active with Phillips & McLaren.

He is survived by his widow, Mrs. Bertha Bryan Phillips; one son, Chester; twin daughters, Mary J. and Martha J. Phillips; his father, W. J. Phillips, 343 South Rebecca St.; two sisters, Mrs. S. W. Murray of Los Angeles, Cal., and Mrs. C. R. Duty of Ingomar, Pa., and one brother, Homer Murray Phillips, Pittsburgh.

Obituary

William Henry Griffiths, aged 67, president of the Griffiths Charcoal Iron Mills, Washington, Pa., died at his home in that city, Aug. 12. Mr. Griffiths was born in Boston, Staffordshire, England, and came to this country at the age of 17, locating in Pittsburgh. In 1895 he removed to Washington, Pa., where he established that city's first tin plate plant which he three year's later sold to the United States Steel Corp. In 1902 he erected a second plant.

August A. Krauenheim, president of the Iron City Sanitary Mfg. Co. died at his home Aug. 10. For a number of years Mr. Krauenheim was president of the Epping-Carpenter Pump Co., serving in that position until one year ago when the company was consolidated with the Worthington Pump & Machinery Corp.

Walter N. Lowell, for 30 years superintendent of the Waterbury Brass Co., Waterbury, Conn., died at his home in that city, Aug. 5, after a long illness. He was 69 years old. He previously was connected with the Pratt & Whitney Co., Hartford, Conn., and was well known professionally.

John Kryl, president of the Pilsen Foundry & Iron Works, Chicago died Aug. 15 at his home, aged 53 years. He was taken ill several weeks ago while on a European trip, reaching home a month ago.

Equipment Demand Still Inactive

Restricted Foundry Operations With a Dearth of New Construction Limits Buying, Although Inquiries Continue To Appear in Fair Volume—Replacements Predominate

LITTLE change was noted during the past two weeks in either the demand or inquiry for foundry equipment. Practically no new construction is contemplated and buying is confined to replacements or to purchases by foundries of machinery necessary to the solicitation of new lines of castings. The eastern districts seem to be slightly more active than the west, and practically no inquiry is arising from the south. The Ford Motor Co., Detroit, continues to buy foundry equipment from time to time. The installation of nearly 100 tumbling barrels made by the Whiting Corp., Harvey, Ill., was completed recently. The Ford company recently ordered six squeezer molding machines from the Berkshire Mfg. Co., Cleveland, for installation in its plant in Cork, Ireland. The Portage Foundry Co., Barberton, O., is inquiring for an additional cupola.

Demand Continues Light In the East

DEMAND for foundry equipment in the East continues small, little change being noted in either volume of inquiry or buying. New construction remains at a virtual standstill, with the result that what little interest there is is of a routine character. In the export field, the only demand appears to be coming from the Orient, an occasional small order being placed. A recent one called for two rotary pressure blowers, placed by Takata & Co., with the Wonham, Bates & Goode Trading Corp., New York. The American Brakeshoe & Foundry Co., Newark, is asking for figures on sand blast machinery and machine shop equipment. Bids are being received for estimating purposes, in connection with the New Jersey-Manhattan vehicular tunnel. Davies & Thomas Inc., Catasauqua, Pa., are figuring some equipment for the same purpose, and only recently have purchased two 7½-ton electric cranes, with 38-foot span, from the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The J. W. Paxson Co., Philadelphia, has purchased a 10-ton electric overhead from Alfred Box & Co., Philadelphia. While demand generally remains small, prices are showing a firmer tendency due to greatly curtailed operations and to the fact that prices are already below costs in most instances; in fact, on a parity with prewar levels.

Slight Betterment In Pittsburgh District

AN IMPROVEMENT in the sales of foundry equipment is reported by dealers in the Pittsburgh district but the betterment in this direction is only slight. Some manufacturers of foundry equipment report August shipments better than those in July; others, however, still are confronted with dullness. The number of inquiries shows a slight increase although the requirements are only for small equipment. However, buyers appear to be more sincere in their inquiries and a favorable amount of business is resulting. Recent sales include a 1000-pound crane ladle, together with a trolley and hoist, which were installed at the plant of the Dravo Brass & Mfg. Co., Pittsburgh, by the J. S. McCormick Co., Pittsburgh. While manufacturers of heating apparatus and sanitary equipment appear to show a fair percentage of operation, yet there is little business coming to makers of foundry equipment from this class of the trade. Ingot mold makers are inquiring for equipment and in this connection there is a fair demand for rollover machines. The only sale of molding machines reported this week was one for a pump company at Aurora, Ill. The sale was closed by the Herman Pneumatic Machine Co. The Duquesne Steel Foundries purchased several torches recently which will be used for pre-heating purposes in connection with oxyacetylene welding. Railroads are showing a better tendency toward placing business with those engaged in the foundry equipment field and in this connection the Pennsylvania railroad recently purchased several items of repair equipment which included automatic valves, torch nozzles and hose fittings. The Fort Pitt Steel Casting Co. now is experimenting with various types of ladle dryers and perhaps will be in the market for this equipment shortly. The Heppenstall Forge & Knife Co., Pittsburgh, was a recent purchaser of a few rivet forges and automatic safety valves. No sales of cranes are reported. Orders for a large amount of machinery and equipment recently were placed by the Nitro Foundry Co., Nitro, W. Va., which was organized last year. Henry T. Teichman, president of the company, expects actual production will be possible within a few weeks. The Enterprise Foundry & Machine Works, Bristol, Tenn., is remodeling some steel buildings, which will be used as a plant for the manufacture of mine cars. Practically all necessary machinery and equipment has been purchased.

Situation Steady In Chicago

THAT the demand for foundry equipment and supplies has ceased its downward movement and at least is holding its own is evident at present. Some inquiry continues to be met, but in the main buying is slack. Some producers and sellers find a constant stream of inquiry, but have the experience of seeing this develop into nothing, and sales are difficult to put over. While foundries are buying and melting more iron than during the summer, they do not show signs of needing further equipment and buying of supplies is also light. Among builders of molding machines some business is noted, both heavy and light types being sold from time to time, although the volume of business is far from what is desired. One builder in this market finds foundry activity in Canada is greater than in this country and has sold some equipment there. Brass and iron castings will be manufactured in the plant addition now under construction for the International Seal and Lock Co., at Hastings, Mich. The capital stock of the Columbus Foundry Co., Columbus, Ind., recently was increased from $15,000 to $35,000. Kaestner & Hecht Co., Chicago, have purchased from A. M. Castle & Co. two store buildings formerly occupied by the Union Wire Mattress Co. at the corner of Blackhawk and Cherry streets. A new foundry and machine shop is to be equipped for the manufacture of freight and passenger elevators.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

The plant of the Vulcan Iron Works, Jersey City, N. J., recently was damaged by fire.

Plans are being prepared by the Haynes Tractor Co., Kokomo, Ind., for the erection of a plant building.

The Coast Welding & Blacksmith Co., 527 West Seventh street, Los Angeles, plans the erection of a plant building, 26 x 50 feet.

The capital stock of the Naugatuck Valley Crucible Co., Huntington, Conn., recently was increased from $550,000 to $650,000.

Plans are being prepared by architects for the J. Toy Co., Bridgeton, N. J., which contemplates the erection of a foundry building, 40 x 80 feet.

The National Piston Co., New York, recently was incorporated with a capital stock of $5000, by J. E. Diamond, J. E. Baldwin, H. Moakley and E. E. Holmes, 15 William street, New York.

U. T. Hungerford Brass & Copper Co., 510 Arch street, Philadelphia, nas leased the building formerly occupied by the A. P. Swoyer Co. and will take immediate possession.

Advices have been received to the effect the capital stock of the Milwaukee Flush Valve Co., 111 Reservoir street, Milwaukee, has been increased from $50,000 to $75,000.

Capitalized at $400,000, the Pitt Tractor Co., Wilmington, Del., recently was incorporated. The Colonial Charter Co., Ford building, Wilmington, was named as the incorporator.

The Stobe Repair Co., Newark, N. J., has purchased property, now occupied under lease, and some alterations are reported as planned in the near future.

The Windsor Machine & Tool Works, Ltd., Windsor, Ont., recently was incorporated with a capital stock of $500,000, by G. M. Smith, William F. Fowler and L. A. Wilkie.

The Franklin Air Compressor Works, Norristown, Pa., recently was incorporated with a capital stock of $50,000, by George C. Yates, 27 West Pomona street, Philadelphia, and others.

The United States Heating Appliance Co., Philadelphia, has been incorporated to manufacture furnaces, stoves, etc., by Harold C. Lansinger, Frank A. Cabeen Jr., and Edward L. Reeves, Paulsboro, N. J.

Capitalized at $20,000, the Sunshine Metal Bed Co., Brooklyn, N. Y., recently was incorporated under the laws of New York, by G. and H. Puchkoff, D. Bremen and S. Hellinger, 309 Broadway, New York.

Deved Bros., 140 West Mount Royal avenue, Baltimore, recently was incorporated with a capital stock of $25,000 to engage in the manufacture of sash weights, etc., by Garrett F. and George C. Deved and Albert M. Sproesser.

The Contraflow Heaters, Ltd., Toronto, Ont., has been incorporated with a capital stock of $100,000, to manufacture furnaces, heaters, etc., by Fred H. Barlow, 32 Breadalbane avenue, F. C. L. Jones, 36 Toronto street, and others.

Brass and iron castings will be manufactured in the plant addition now under construction for the International Seal & Lock Co. at Hastings, Mich. It is expected the construction work will be completed shortly and installation of machinery and equipment started.

The Cowles Heater Co., New York, recently was incorporated to manufacture heaters, etc., with a capital stock of $100,000. The incorporators of the company are H. L. Cowles, J. J. Young, J. A. Trimble and F. A. Hutson, 41 Park Row, New York.

Capitalized at $125,000, the General Steel Casting & Machine Co., Jersey City, N. J., recently was incorporated under the laws of New Jersey. A. F. McCabe, 15 Exchange place, Jersey City, was named among the incorporators of the company.

Articles of incorporation have been filed by the Acme Grey Foundry Co., Milwaukee. The capitalization has been named as $25,000, and the incorporators include Warren J. Wheeler and Charles W. Brown, both of Milwaukee. Arthur Breslauer, 120 Wisconsin street, is attorney for the company.

Word has been received from the Enterprise Foundry & Machine Works, Bristol, Tenn., through W. F. Daniel, president of the company, to the effect it is remodeling some steel buildings which will be utilized as a plant for the manufacture of mine cars. All necessary work is being done by the company itself and practically all necessary machinery and equipment has been purchased.

Capitalized at $75,000, the Electric Manganese Steel Co., Reading, Pa., recently was incorporated under the laws of Pennsylvania, to engage in the manufacture of iron and steel materials, etc. The incorporators of the company were Ray A. Houck, 117 West Windsor street, Reading; Samuel McClure, Ninth and Penn streets, and Alvin Schmehl, 721 Lincoln street, Reading, Pa.

Establishment of permanent plant and offices at Grafton, Wis., has been completed by the Lincoln Light Corp., of Milwaukee, organized several months ago with a capital stock of 150,000 to manufacture farm electric plants, etc. The company's plant is housed in a large addition built to the foundry and machine shop of the Jungers Stove & Range Co., which will be the source of castings and machined parts.

Sidney Thompson, president and treasurer of the Defiance Screw Machine Products Co., Defiance, O., has taken an interest in the Napoleon Tool & Machine Co., Napoleon, O. The name of the latter organization has been changed to the Napoleon Products Co. and the capitalization increased from $40,000 to $50,000. The company operates a modern repair department and plans are now being prepared for the manufacture of automotive parts and accessories.

The Globe Stove & Range Co., Kokomo, Ind., has employed a force in anticipation of beginning operations soon to take care of the increased fall market for their products. It will be several weeks before the full force of 350 men will again be employed it is understood, however. It will be necessary to spend several days in getting the furnaces in operation and starting the first departments, before the run of product will be far enough along to require the work of all departments.

The Northwest Engineering Corp., Green Bay, Wis., has filed articles of incorporation with $400,000 in preferred stock and 1000 shares of common stock of no par value. The firm will manufacture and market cranes and hoists, specializing in a crawler type of yard crane designed for use in logging, lumbering and general industrial purposes. The crane is mounted on a crawler type of tractor chassis. The incorporators of the company are Victor I. Minahan Sr., Joseph F. Finzel and Victor I. Minahan Jr.

Negotiations between the Moline Plow Co., Moline, Ill., and the Moline Engine Co., which operated the Root & Vandervroot plant in East Moline, Ill., manufacturing gas engines, for the taking over by the Moline Plow Co. of the machinery and business of the Moline Engine Co. have been resumed. This transaction had been considered a year ago it is understood, but was never closed. The machinery in the East Moline plant is being dismantled and removed to the tractor plant of the Moline Plow Co. in Rock Island, Ill. Here it will be used in the production of tractor and automobile castings it is said.

The Perfection Hoist & Engine Co., 221 Grand avenue, Milwaukee, has selected Two Rivers, Wis., as the location of its permanent works and headquarters, having purchased the former plant of the Two Rivers Plating & Mfg. Co., until now occupied by the Victor Krefl Mfg. Co. The Perfection company was organized two years ago and manufactures farm lighting-plants and mechanical horizontal hoists for motor dump trucks. It is moving its machinery and equipment to Two Rivers and will be on a production basis within a few days. The Krefl company, which manufactures automobile accessories, is transferring its equipment to the building formerly used as a machine shop by the Two Rivers Woodenware Co.

New Trade Publications

LOCOMOTIVE CRANES.—The economical handling of material by locomotive cranes is pointed out in a 12-page illustrated bulletin recently published by the Brown Hoisting Machinery Co., Cleveland. According to the bulletin, the type of crane described, was developed to meet the handling needs of practically every industry and it will fill all requirements for a light, flexible machine, of which it is a type. It is all-steel full-revolving, and is built to operate by steam, electricity or gasoline engine. It may be mounted on railroad trucks, creeper trucks or traction wheels. The bulletin is filled with illustrations showing the crane at work in various industries, engaged in handling many different kinds of materials.

CRANES—Electric traveling cranes, bridge and gantry cranes, hand power cranes, pillar and jib cranes and derricks, electric hoists, air jacks, air hoists, trolleys, overhead tracks, turntables and transfer tables, are described and illustrated in a 32-page illustrated booklet recently published by the Northern Engineering Works, Detroit.

MOTORS AND GENERATORS—The Allis-Chalmers Mfg. Co., Milwaukee, has published an 8-page illustrated bulletin in which direct current motors and generators are described and illustrated. The line described recently was brought out by the company and is designed for belted as well as direct applications. It is said to be particularly suited to the exacting requirements of machine tool service. Among some of the important features as pointed out in the bulletin are: Ratings and speeds corresponding to standard 60-cycle induction motors; a complete line of constant and adjustable speed ratings; cast-steel yokes; dust-proof bearings; windings treated to resist oil and moisture; conduit terminal boxes on all motors; improved box-type brush holders and interchangeability of parts.